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STATE OF MONTANA
STATE HIGHWAY COMMISSION

Manual of Instructions Construction

FIRST EDITION

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D. A. McKINNON, State Highway Engineer
E. B. DONOHUE, Ass't. State Highway Engineer

MAY, 1936

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STATE HIGHWAY COMMISSION

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D. A. McKINNON, State Highway Engineer
E. B. DONOHUE, Ass't. State Highway Engineer

MAY, 1936

PRESS OF
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May 1, 1936.

TO THE EMPLOYES OF THE
STATE HIGHWAY COMMISSION:

This Manual of Instructions has been assembled and is presented to serve as the basis for the disposition of all engineering and administrative affairs incident to the location and construction of roads and bridges in Montana. The authorities and responsibilities assigned and the approved procedures outlined for compliance are so disposed in the interests of efficient and adequate control of our work and are in affect from the date of publication.

These instructions are based on precedent, the knowledge gained by past experience, and the approved practices inferred or implied in the Standard Specifications and as such, not only repeat instructions issued in memorandum form in the past, but advance new methods which it is contemplated will place the organization on the highest plane of efficiency. In so designing or assembling the basis for the administration of our affairs, it is not intended that the field engineer will be submerged in red tape, but rather, that he will be established on a standardized basis consistent with the demands of efficiency and economy. The engineer should acquaint himself with all details in the Manual, particularly those topics treating with items of seeming minor importance, as a broad knowledge of detail will expedite the work in the Headquarters and Division Offices.

I believe the Manual to be comprehensive, as it treats with the impersonal aspects of engineering, however, success in any work such as ours depends on the personal qualities of the organization, and for this we are dependent primarily on the contacting agents, the field engineers. No course, within the confines of one cover, can be prescribed to cope with all contingencies arising in the field of highway engineering; only those fundamentals treating with general policy which have been founded on experience are cited in the Manual, and at this point I wish to touch on the broad and varied properties of a competent engineer.

An engineer in the performance of his duties will assume certain qualities befitting a businessman, a technical adviser and supervisor, an engineering inspector and a public servant; it is trusted that our organization will not suffer by comparison. The contractors are prepared, as business men, to furnish a commodity, acceptable on the basis of the Standard Specifications and in such category, they are entitled to a business-like attitude being extended them from the engineer. Similarly, they are financed on a basis compatible with the importance of our programs and as such they should not be subjected to inspection which will demean not only their efforts, but those of the engineer. Engineering inspection should be effected along the lines dictated by courtesy and good judgment, the latter qualification being an essential factor in the make-up of any engineer. Our records as engineers on public works should be distinguished by economy and efficiency; our efforts in this classification will materially influence the costs incident to road building. We can by co-ordination and co-operation, return dollar for dollar of the taxpayers money.

In conclusion, it is my desire, and I know that you concur, that the Montana Highway Commission will be recognized as being second to none in the field of highway engineering and first in the field of co-operative and friendly effort.

Signed,

D. A. McKINNON.
State Highway Engineer.

CHAPTER I

ORGANIZATION AND GENERAL DETAILS CONSTRUCTION DEPARTMENT

1. ORGANIZATION

1.1 Headquarters Office The Construction Department is concerned generally with the administration of all highway building activities. The scope of the work has been broadened in recent years to include the fair and impartial regulation of the special provisions as regards the labor employed by the contractors. To cope with the requirements of efficient administration, certain powers and authorities have been assigned in the Headquarters Office. The Highway Commission is directly represented in the person of the State Highway Engineer, who is assisted in all matters pertaining to construction work by the Assistant State Highway Engineer, acting in the capacity of Construction Engineer. His specific duties within the department are generally as follows; the supervision of all field and office engineering, the inspection of projects, and the clearing of all pertinent business through the channel of his office.

1.2 Division Offices Division Offices are maintained in ten districts of the State, each in charge of a Division Engineer. All communications from the field to the Headquarters Office will be cleared through the offices of the Division Engineers, and the Construction Engineer in turn will transact his business as the representative of the State Highway Engineer through this channel. The Division Engineer is assisted by a staff comprised in the order of their capacities as follows: Resident Engineers, Project Engineers, Inspectors, Labor Inspectors and Clerks.

1.3 Construction Engineer The Construction Engineer, serving in a broadly supervisory capacity, will consult on all matters which merit special attention, particularly as applying to conformation with the plans and specifications. His advice and direction is available at all times to the Division Engineers.

1.4 Pre-Construction Engineer The Pre-construction Engineer, being in charge of all operative activities prior to the award of contracts, will also be active in the Construction Department in that all matters involving right-of-way will be referred to his office for conclusion.

1.5 Office Engineer The Office Engineer will advise on all matters pertaining to the Specifications, will check estimates and prepare vouchers for same and will be in charge of filing all construction data on completion of work.

1.6 Testing Engineer The Testing Engineer is responsible for the making of physical or other tests of materials as required, and for the prosecution of such investigation or research as assigned in the department. All materials entering in the construction work must be certified acceptable by the Testing Engineer or his authorized inspectors in the field. Communications, by the authority of the Construction Engineer will be directed through the offices of the Division Engineers.

1.7 Assistant Bituminous Engineer The Assistant Bituminous Engineer is in charge of all road oiling, subject to the advice and direction of the Construction Engineer.

1.8 Equipment Engineer The Equipment Engineer will be active in the Department in that all mobile equipment will be operated according to his recommendations and gas and oil will be purchased according to contracts arranged through his office. Repairs to equipment will be made in the field shops under his general supervision.

1.9 Division Engineers The Division Engineer is in direct contact with all construction work in his district and to him is charged the responsibility for the proper conduct of the work.

1.10 Resident Engineers The Resident Engineer is in charge of construction work in his district as designated by the Division Engineer and it is his duty to direct his assist-

ants to the end that the work will be completed in a satisfactory manner. All communications from the field will be directed through the Division Office.

1.11 Project Engineers The Project Engineer is charged with two important responsibilities, first, the technical supervision of construction work, and second, his responsibility to the organization as it relates to public opinion of the Highway Department. The Project Engineer is assigned to work in such a manner as to be in contact with the public and his personal conduct, both on and off the work and the results of his activities as evidenced by the completed work, form a basis for public comment, adverse or otherwise. Needless to say, service in this capacity warrants good judgment, an adequate knowledge of highway engineering and a considerable ability to serve for and with the public.

His duties in a strict engineering capacity are to stake and prepare the work for construction, to direct the prosecution of the work along the lines dictated by the plans and specifications, and to submit such reports as are required by the Division Office and the Headquarters Office. The Resident Engineer will direct the Project Engineer in all matters pertaining and incident to the work.

1.12 Instrument Men Instrument Men will be directed in their work by the Project Engineer and with the assistance of Rodmen and Chainmen will furnish engineering assistance to the contractor.

1.13 Inspectors Inspectors will be detailed to the work as required, particularly on surfacing work and small concrete structures.

1.14 Division Labor Inspectors The office of Division Labor Inspector has been created to foster efficiency in the application of the special provisions now in effect as regards labor on highway work. He will instruct the Contractors in the preparation of payrolls and aid the engineering staff in checking the payrolls and in the submission of reports required by the Bureau of Public Roads. His duties may be changed at the direction of the State Highway Engineer as necessitated by changes

in Special Provisions or Federal Labor Regulations. All communications will be directed through the Division Offices.

2. GENERAL DETAILS

1.15 Review Plans and Specifications On notice of assignment to construction work, the Project Engineer should review the plans and specifications, preferably with the Division Engineer. The plans as prepared are according to standards set by the Bureau of Public Roads and the Highway Department; however, the treatment will vary according to the peculiarities of different localities and this matter should be thoroughly discussed.

1.16 Equipment and Supplies The Project Engineer should check his equipment and, anticipating his needs according to the probable duration of the work, should draw on the Accounting Department. Requisition Form No. 46 is provided for this purpose.

1.17 Addresses The Project Engineer will establish an office, if away from a permanent residency and advise the Division Office as to his local address. This knowledge should also be imparted to the local post office and the telephone and telegraph companies.

1.18 Plans and Specifications The plans and standard practices indicated thereon supplemented by the specifications and special provisions constitute the control of all work and it is imperative that the engineer acquaint himself thoroughly with these details.

1.19 Schedule of Work During recent years the highway program has been sponsored by the Federal Government as a medium through which to relieve unemployment. Every effort has been exerted to get the work started for the instant benefit of those in need, with a resultant decrease in time for the engineer to lay out the work; consequently, the problem of accurately administering the affairs coincident with the construction of a project during the limited time available is one that merits considerable thought.

Immediately on award of the contract, the Project Engineer should contact the contractor and discuss the work, and then synchronize the activities of his party with the schedule proposed by the contractor. It is imperative that no inconvenience be occasioned the contractor through delays of the engineer. In the disposition of the work within the party, certain routine business, such as the preparation of weekly reports and equipment reports, the submission of samples, the checking of payrolls and the preparation of estimates, should be assigned to the assistants. In so apportioning the duties, it is not intended that the engineer lose all account of details but rather that he be left free to devote a major portion of his engineering capabilities to the ultimate benefit of the field work.

1.20 Laws

Generally speaking, all phases of construction work are predicated on the dimensions shown in the plans and the limits given in the specifications and special provisions. All design work is prepared with intelligent use of known engineering principles, the specifications are compiled according to practice general throughout the country and the contracts are awarded and executed according to all requirements of law.

1.201 Right of Way

The act of building highways is therefore correct and according to statutes; however, the engineer in the field is charged with some legal responsibilities, chief among them being the proper consummation of all agreements entered into by the Right of Way Department. No trespass will be allowed either by the Contractor or the Engineer. The Contractor shall not be allowed to enter upon and work on any land for which the Right of Way has not been obtained.

1.2011 Fencing

In the interests of safety for the traveling public, the Commission has adopted a very definite attitude in the matter of fencing areas bounding the Right of Way. This policy is given in detail as follows:

1. Field Agents to Inform Landowners of Necessity of Fencing.

Field agents, at the time of initial negotiations with resident landowners, will inform landowners verbally, but pointedly, that the Commission, in pursuing its policy to make the highways of Montana

as safe for traffic as possible, will **absolutely require** that fences be built and properly reset wherever payment has been made by the State therefor.

2. Provision to Be Placed in Option.

The following provision will, as soon as possible, be placed in the options:

"The undersigned agrees that, upon payment by the State of Montana of the fencing compensation mentioned herein, the undersigned shall build or reset the fence specified upon the reverse side hereof, within a reasonable time after highway grading operations are completed; and the undersigned further agrees that if the undersigned does not build said fence within the time specified, the undersigned shall refund said fencing compensation, upon notice and demand, to the State of Montana."

3. Notice of Necessity of Fencing to Be Attached to Deed When It is Sent for Completion.

When the deed is sent out for execution, together with a warrant for the agreed compensation, including the fencing allowance, the following notice, printed upon bright yellow paper will be attached to the deed:

"STATE HIGHWAY COMMISSION OF MONTANA
Helena
TO GRANTORS OF RIGHT OF WAY TO
THE STATE OF MONTANA

This Commission desires to make the highways of Montana as safe for traffic as is humanly possible.

Stock, grazing upon highway rights of way, particularly at night, is a source of grave danger to motorists. Frequently the animals are killed or injured. These dangers can be minimized if owners will endeavor to keep animals from trespassing upon rights of way.

If the State of Montana is purchasing right of way from you, and is paying you for building or resetting fence, it will **absolutely require** that such fence be built or reset within a reasonable time after grading operations are completed. (See provision in deed.)

Your cooperation is most important, and is earnestly solicited in behalf of public safety.

STATE HIGHWAY COMMISSION
OF MONTANA."

The above notice should forcibly call the owner's attention to his obligation to fence, in those cases where he is to receive compensation therefor.

4. Fence Inspections to be Made Under Direction of Division Engineers by Project Engineer.

Within a reasonable time after the completion of grading operations, a detailed preliminary station to station inspection of fencing will be made under the direction of the Division Engineer. This report should conform to the parcel and station numbers shown in the report of the Right of Way Field Agent, thus facilitating the identification of the owner and the right of way. Project Engineers will be furnished with one copy of each Right of Way field report. For the sake of uniformity the preliminary report should contain substantially the following headings:

Project Number..... Location .....

PRELIMINARY FENCING REPORT.

.....
Date

Parcel Owner..... Address..... Sta. to Sta..... Status.....

5. Inspector Will Personally Contact Non-Conforming Resident Landowners.

At the time of the preliminary inspection, the inspector will consult personally with any resident landowners who have not built or reset their fences, ascertain why they have not done so, and call their attention to their obligation to do so. The inspector should embody in his report to his Division Engineer, their reasons for not doing so.

6. Division Engineer Will Communicate with Non-Conforming Non-Resident Landowners, Other Than Federal Land Bank, and the State of Montana.

Upon receipt of the preliminary fencing reports from the inspector, the Division Engineer

will write to the non-conforming non-resident owners and request immediate compliance with their obligation to fence, as set forth in the easement deed as follows:

> "It is further agreed between the parties hereto, for the consideration hereinbefore mentioned, that the undersigned shall build or reset any fence along the right of way herein described as has been heretofore agreed upon, and if the undersigned does not build or reset the fence along the said right of way within a reasonable time after the completion of highway grading operations, the undersigned hereby agrees to refund to the State of Montana the consideration herein mentioned for said fencing, upon notice and demand by the State of Montana."

7. Fences Along Right of Way Through Land Owned by Federal Land Bank and the State of Montana.

The Right of Way Department will communicate with the Federal Land Bank and with the Board of State Land Commissioners where it is found upon preliminary inspection that fencing has not been reset or built along right of way through land owned by the Federal Land Bank and the State of Montana.

8. After Final Inspection Report to be Made to Right of Way Department.

After a reasonable length of time (within the judgment of the Division Engineer) a final fence inspection will be made, and full details pertaining to any owner who refuses to fence will be reported by the Division Engineer to the Right of Way Department. Copies of the preliminary fencing report should be sent to the Right of Way Department but no action will be taken by the department upon it.

9. Division Engineers Responsible in Their Districts for Pressing Action Until Final Stage.

It is proposed under this plan to have the Division Engineers handle fencing matters during the intermediate and to the final stage, and the responsibility will be for his seeing that everything possible is done to assure the resetting and/or construction of the required fencing.

10. The Idea of Cooperation for Public Safety to Be Stressed.

It is believed that the idea of cooperation for public safety should be stressed until it becomes evident that it will avail of nothing to continue proceeding in such a manner.

11. Legal Fences.

Landowners will be guided in resetting and constructing fences, by the definition of a legal fence as specified in Section 3374, Revised Codes of Montana, 1921, a copy of which follows hereafter. A copy of Section 3374 will be sent with the deed to each landowner who is to build or reset fence. No fence should be approved which does not measure up to the minimum type of legal fence as specified in the first part of paragraph one of Section 3374 R. C. M. 1921 mentioned above.

12. Legal Fences Defined.

SECTION 3374 REVISED CODES OF MONTANA, 1921.

Any one of the following, if not less than forty-four inches nor more than forty-eight inches in height, shall be a legal fence in the State of Montana:

1. All fences constructed of at least three barbed, horizontal, well-stretched wires, the lowest of which must not be less than fifteen inches nor more than eighteen inches from the ground, securely fastened as nearly equidistant as possible to substantial posts, firmly set in the ground, or to well-supported leaning posts, not exceeding twenty feet apart, or thirty-three feet apart where two or more stays or pickets are used equidistant between posts; provided, that all corral fences which are used exclusively for the purposes of inclosing stacks which are situated outside of any lawful inclosure shall not be less than sixteen feet from such stack so inclosed, and shall be substantially built with posts not more than eight feet distant from each other and not less than five strands of well-stretched barb wire, and shall not be less than five nor more than six feet high; provided, further, that any kind of a fence equally as effectual for the purpose of a corral fence may be made in lieu thereof.

2. All fences constructed of any standard woven wire not less than twenty eight inches in height, securely

fastened to substantial posts not more than thirty feet apart, shall be a legal fence; provided, that two equidistant barbed wires shall be placed above the same at a height of not less than forty-eight inches from the ground.

3. All other fences made of barbed wire, which shall be as strong and as well calculated to protect inclosures as those above described, shall be considered legal fences.

4. All fences consisting of four boards, rails, or poles, with standing or leaning posts not over seventeen feet and six inches apart; provided, that if leaning posts are used, there shall be a pole or wire fastened securely on the inside of the leg or support of such leaning post.

5. All rivers, hedges, mountain ridges and bluffs, or other barrier over or through which it is impossible for stock to pass.

1.2012 Agreements Structures will be checked in place according to the Right of Way Agreements.

1.2013 Responsibilities It is to be emphasized that no Contractor should be allowed to encroach on private property for purposes of borrow or to secure aggregates, without proper authority.

1.202 Railways When work is carried on along a railroad right of way, particular care should be taken that the railroad right of way fence is not disturbed or damaged to thus allow stock to enter upon the railroad right of way. It follows that if stock is on the right of way, that damages will be sustained in most cases, with claims for restitution being presented the railroad company. These claims will then be referred to the contractor for settlement to the satisfaction of all concerned. The responsibility is, of course, the contractor's; however, in the interests of amicable relations, the Project Engineer should extend every effort to forestall the possibility of damage suits.

If materials are being hauled across a railroad, the Project Engineer will see that the crossing is kept clear of debris to safeguard railway traffic.

1.203 Poles The division of costs for the removal and/or replacement of utilities is a clear cut issue and established by law

as such. The law governing this feature is interpreted as follows:

a. If poles are located on a public right of way and their removal is occasioned by construction work, the expenses will be borne wholly by the utility company.

b. If the poles are located according to a definite franchise or easement, the cost of moving them would be borne by the State.

1.204 Motor Licenses All trucks and motor vehicles shall be properly licensed for the current year before being operated on construction work. The specific law applying is stated in part as follows:

1760.7 Duty of Foreign Licensed Motors Here on Business or for a Gainful Occupation.

Before any foreign licensed motor vehicle shall be operated on the highways of the State for compensation or profit, or the owner thereof is using the vehicle while engaged in gainful occupation or business enterprise, in the State of Montana, including **highway work,** the same shall be registered and licensed in this State in the same manner as is required in the case of domestic owned vehicles. . . . . "

The operator of the truck shall certify either by receipt or the possession and display of license plates that all fees have been paid to register the vehicle.

In this same connection, no trucks carrying dealers' licenses are to be allowed to take part in the work.

The engineer shall check further to see that the license plates are not interchanged or that two trucks are operated under one registration certificate.

1.205 M. R. C. Certificates Where the contractors hire local trucks on a yard mile or hourly basis, Montana Railroad Commission certificates will be required.

1.206 Working Hours Section 3079, Revised Codes of Montana, 1921 specifically establishes eight hours as a maximum working day. No exceptions are made for highway work of any type, consequently no engineer can authorize an extension of the working time per day for the contractor.

1.207 Poll Tax The contractor is required by law to deduct poll taxes from wages due employees, provided, however, that the assessor presents his demands in writing.

1.208 Garnishments When garnishments are served locally, the following returns will be delivered immediately to the officer serving the notice:

"Nothing in our possession due the defendant, see Montana Reports, Volume 67, page 244, Case No. 5126."

This notice does not apply if the warrant is in the possession of the employee's immediate superior. If the warrant is in the possession of the employer, it should be delivered to the officer, the return would then be filled out to read "State Warrant No..... in the amount of....."

In all cases where the warrant is delivered to the officer, a receipt should be taken showing the number and amount of the warrant and the payee.

If suit is brought against an employee of a contractor, generally the plaintiff attaches any funds in the hands of the contractor, due the employee.

Notices of assignment, writs of attachments, etc., against the contractor, when monies are due him from the State, are generally filed with the State Auditor.

1.21 Estimates Form No. 14 has been provided to the field men, upon which they will note the monthly progress during the course of construction. The estimates should be carefully prepared and thoroughly checked as they are the basis for all payments to the contractor.

1.211 Procedure A normal procedure in making an estimate would begin with a field inspection trip over the project, noting the station to station intervals in which the work is being carried on and the stage to which the work has been advanced. The Engineer will then prepare an estimate noting the percentages complete, which will be retained in his own files. Copies in triplicate, without the percentages, shall then be made and forwarded to the Division Office. One copy will be retained at that point and the original and one copy will be forwarded to the Headquarters Office after approval by the Division Engineer.

1.2111 Segregation When a contract incorporates sections having separate project agreements and detail estimates, estimates must be submitted according to the segregation thereon.

1.212 Earnings No progress estimates will be submitted for a period in which the earnings do not net $500 or in which there is no work performed and the Headquarters Office is to be so notified. The one exception to this order would be in the case wherein large earnings on a contract would be held up in the final estimate on completion of the work. A semi-final estimate would then be issued providing the earnings (not including extra work), exceed $2,000.

1.213 Periods All estimates are to be in the Headquarters Office within five days of the termination of the estimate period. The Divisions have been assigned separate periods, ending as follows:

Division No. 1-10.....10th of month
Division No. 2-9.....20th of month
Division No. 3-8.....5th of month
Division No. 4-7.....15th of month
Division No. 5-6.....25th of month

1.214 Objective To standardize the preparation and submission of estimates throughout the State, the various steps required will be outlined in full as applying to general construction. The instructions will be amplified when the manual treats with the separate items making up the whole of construction work.

1.2141 Page 1 of the Estimate Certain headings are indicated on page 1, these to be completed according to the following directions:

1. Division No.....
   According to assignment
2. Project No.....
   Refer to the detail estimate and transcribe exactly, the number, the unit number, and the distinguishing initials indicated thereon.
3. Name.....
   Refer to the detailed estimate and transcribe
4. County.....
   Refer to the detailed estimate and transcribe.
5. Estimate No.....
   Estimates are numbered according to the actual number issued, i. e., in the

event of no work or deficient earnings during a period, no estimate would be issued, the count being continued in succeeding estimates on resumption of work. The next to the last estimate in addition to its ordered number will be further distinguished by the words "semi-final."

The final estimate would be indicated by the word "final" along with the number in sequence. The words "PROGRESS ESTIMATE" will be crossed out in the general heading and "FINAL ESTIMATE" substituted as an additional means to identify the final estimate.

6. For Period from.....19.....
to.....19...., inclusive

The first estimate will show quantities beginning with the date the work was reported started and ending on the date designated for the period within the Division. In succeeding estimates the period will be shown according to that assigned the Division; for example, in Division No. 1 the full estimate period would begin on the 11th of the preceding month and end on the 10th of the succeeding month. In the event of a shutdown within a period, the estimate interval would end on the date the shutdown order was issued. On resumption of work and submission of estimates, the period would extend from the day after the shutdown through the intervening periods to the end of the current period. If a shutdown order is issued during a period at such time that the earnings will not have totaled $500, the succeeding estimate will be dated from the last estimate submitted through the current period. Semi-final estimates when submitted will date from the last estimate through the date on which the estimate is sent in. The period covered in the final estimate will

extend from the date the semi-final was prepared to the latter of the dates on which the road is accepted by the State and Bureau of Public Roads, this date to be inserted at the Headquarters Office. In the event the semi-final was sent in on the end of the regular estimate period, the final would date therefrom.

7. Contractor..... Address.....

Refer to the contract and transcribe as shown.

In some cases, the contractors prefer that their payments be sent to other points than that designated as their address in the contract, and this being the case, the Accounting Department should be so notified, both by memorandum and by the address given on the estimate blank.

8. Completion date.....19....

Refer to the contract and transcribe as shown.

9. Constructed length.....

Record on final estimate.

10. Remarks .....

Note the dates of shutdown and the resumption of work to supplement further the notices thereof to the Headquarters Office.

11. Other Headings.

All headings denoted thusly (*) are to be filled in by the Headquarters Office, including "Amount Due This Estimate."

12. Certification.

Certify the estimate with original signature on all copies of the estimate.

13. Recommendation.

The Division Engineer will recommend the estimate for approval with his original signature on all copies of the estimate.

14. Approval.

The State Highway Engineer or the Secretary will approve the estimate for preparation of vouchers in Helena.

1.2142 Pages 2 and 3 of the Estimate

The headings will be noted on the estimate per the following directions:

1. Project No.....
Transcribe from the Detail Estimate.

2. Estimate No.....
Check with the carbon copy of the claim returned from the Headquarters Office on which the quantities are listed and extended to monetary values. The preceding estimate number is correctly noted thereon.

3. Item No.....
Transcribe from the field copy of the Detail Estimate.

1.2143 Descriptions

All items as distinguished from structures shall be placed in the upper half of the blanks. Columns are provided for this with appropriate basic headings; in the event that there is no title fitting certain items in the work, change the descriptions on the blank to fit conditions. If additional work is involved, under the provisions of a Supplementary Agreement, (See Par. 1.24) show the quantities under the A.W.O. number on which the Supplementary Agreement is based. Quantities showing the installation of structures and appertaining work will be shown on the lower half of the blanks in the spaces designated therefor. If the space provided is not adequate to contain all allowances for the estimate, use additional blanks as required. Do not attempt to enlarge the form by pasting additional sheets or parts of sheets to the first copy. Totals and sub-totals in this latter case will be carried to the last sheet of the estimate to compute the Total This Estimate.

1.2144 Division

In order that the estimate be a complete resumé of the work under way, careful consideration should be given to dividing the project in sections, particularly on the upper half of the sheet. Ordinary controls are recommended as follows:

a. Divide the work to show all quantities according to sub-contracts, this for the convenience of the contractor.
b. Divide the work according to any change in the typical section or any other segregation indicated in the Detail Estimate.
c. Once a division is made in the work, show it on

all subsequent estimates, depending on the number of splits entailed. In the development of work on a project containing a number of items, build up the division to accommodate the entry of new work. The quantities listed and segregated in the upper half of the sheet shall always be the total to date and not the total for the period covered by the estimate. The statement of quantities on the lower half of the sheet shall be entered only for new installations during the period; however, on the final estimate all work shall be shown to repeat the knowledge given in the progress estimate. Any item let on a lump sum basis shall be shown on the estimates as a percent completed and not in monetary values.

1.2145 Quantities Quantities shall be listed accurately, according to data secured during the course of the work and should substantiate the routine information submitted to the Headquarters Office in the form of weekly reports, oiling reports, etc. The first operation in listing the quantities after the blank has been headed and item numbers inserted is to place the "Total Last Estimate" in the columns designated. This information is best procured from the carbon copy of extensions. The quantities will then be listed according to the divisions by stationing established in the next preceding operation. To arrive at the "Total This Estimate" on the upper half of the blank, the quantities listed in the body of the estimate will be added, their total placed in the "Total To Date" column, and then the "Total Last Estimate" will be subtracted to ascertain the "Total This Estimate." On the lower half of the sheet the "Total Last Estimate" will be entered as described hereinbefore; however, the "Total This Estimate" will be the sum of quantities listed on the estimate and the "Total to Date" will be the "Total This Estimate" added to the "Total Last Estimate." On the final estimate the quantities will be listed as directed for the upper half of the sheet and the "Total This Estimate" will be computed similarly.

1.215 Contingencies Overruns in quantities will not be shown on progress estimates unless authorized by Additional Work Orders (See Par. 1.22). If the orders are issued to cover specified items in the contract, the quantities will be

shown as a part thereof. If the work is performed according to the provisions of a Supplementary Agreement, the quantities will be listed under the A.W.O. Number authorizing the work. Any work performed under the provisions of an Extra Work Order (See Par. 1.23) will be shown only on the final estimate under the heading provided.

1.216 Supporting Data for Finals The final estimate is a statement wherein the history of the project is completely outlined. Certain supporting data is required by the Bureau of Public Roads to clarify all deviations from the original plans and the information is contained in the "Comparison of Project Agreement and Final Quantities" with appropriate headings as exemplified in the following model:

(Full sized 8½"x11" tissue)

STATE HIGHWAY COMMISSION
Helena, Montana

Federal Aid Project No. 280-A, Unit 1

Item No.	Description	Agreement	Final	Over	Under	W. O. Amt.	Remarks
1	Unc'l. Exc. & Borr.	537,892	475,463		62429		See Note 1
6	18" C.M.P.C.	460	580	120		+120	Note 6 A.W.O. No. 2
18	Poles to move	6	4		2		Note 18 E.W.O. No. 2
	Detours		$462.86	$462.86		$490.00	Note 20 E.W.O. No. 3

Note 1 would explain conditions affecting the under run in full. In Note 6 the contents of A. W. O. No. 2 would be quoted verbatim as a sufficient reason for the overrun.

Note 18 would be a quotation of E. W. O. No. 2 issued to cover the work to be done on the pole line. The quote would then be supplemented by the reasons for not moving all the poles as set up in the project agreement. The difference in monetary values of the E. W. O. as issued and as presented for final payment would then be explained in all details to complete the note. Note 20 would quote E.W.O. No. 3 and then explain the underrun in money to complete the note.

The explanations quoted above are typical to most conditions encountered in the field. Ordinary controls in the preparation of the "Comparison are as follows:

1. All items shown on the project agreement shall be entered in the "Comparison." If there are divisions on the agreement estimate for variant typical sections, different sources of funds or for work to be performed by different parties, make similar segregation on the tabulation;

2. Force account items shown on the project agreement will likewise be shown on the "Comparison" as quantities rather than monetary amounts. All force account work on the removal and replacing of poles shall be entered under the provisions of the Extra Work Order issued to cover same. The explanation of the underruns or overruns extant on completion of the project shall be explained in full in quantity and monetary value.

3. In addition to the items contained in the project agreement, all extra work authorized in A. W. O's. and later supported by Supplementary Agreements shall be entered in the Comparison as overruns and explained accordingly.

4. Extra Work Orders shall be entered and explained as overruns on the Comparison.

1.2161 E. W. O's. One copy of all Extra Work Orders with an account of labor costs and materials costs on the back thereof will be attached to the original copy of the final estimate on its submission. Receipts for money expended for materials are to be attached to the E.W.O.

1.2162 Time The final estimate and supporting data shall be transmitted to Helena within two weeks after the project has been accepted.

1.217 Exception The instructions given herebefore apply specifically to the preparation of estimates covering work performed under the ordinary control of the Construction Department. Under the new program, some contracts may be awarded to include both the road unit and the bridge unit and similarly, estimates when submitted will be under one cover and will summarize the quantities in both units.

1.22 Additional Work Orders Additional Work Orders on Form No. 13, when approved, deliver an authority to the engineer to change the contract quantities on any one project, usually to cope with unforseen contingencies as they develop during the prosecution of the work. An A.W.O. can also be submitted authorizing the engineer to have work performed which is not itemized in the contract. If an order is isued under these conditions, it is later incorporated in the contract by the issuance of a Supplementary Agreement from the Headquarters Office. No orders will be issued appertaining to Right of Way agreements. If work is contemplated, outside the scope defined in the specifications and the contract and not liable to participation by Federal agencies, it may be authorized by an A.W.O. but the order shall be designated "Non-Participating."

1.221 Discussion It is essential that all changes proposed be discussed with the Division Engineer and if possible with the Bureau Inspector. If an order has been issued from the field, discuss all the details on arrival of an Inspector. This will insure prompt consideration in the Bureau offices. The contractor should also be made acquainted with all details and if satisfactory to him, he will inscribe his approval on the face of the original order. It is to be remembered that the Headquarters Office will not approve an Additional Work Order unless it is certified approved by the Contractor.

1.222 Heading The heading of the order should be filled in with substantiating data as contained in the contract, the detailed estimate and prior field records.

1.223 Description In the body of the order give a thorough and adequate explanation of the changes involved; state the reasons, the extent, and the results anticipated; in short, the objective should be to present a clear, concise picture of the change when combined with the Final Estimate as an explanation of overruns and underruns. It should not be necessary to attach a rider or explanatory letter when the order is submitted to the Headquarters Office. Estimates of quantities should be based on intelligent computations and any decreases or increases should be cited. If the change is general throughout the length of the project, show the original contracted quantities under appropriate headings, then the total quantities anticipated under the change and add or subtract to arrive at the net increase or decrease.

1.224 Estimate and Cost The "Estimate and Cost is the restatement of quantities described in the body of the order extended to monetary values. Units, unit prices and the description will conform to the data contained in the detailed estimate for the project.

1.225 Submission The Project Engineer will originate the order making two copies, the original to be forwarded to the Division Office for check and approval. The Division Office will prepare five copies for the convenience of the Headquarters Office and later transmittal to the Bureau. If changes are made in the Division Office, either in wording or quantities, corrected copies will be forwarded to the Project Engineer for his files.

1.226 Control An A.W.O. is a very definite statement and the work involved in the change should be done according to the provisions of the order, particularly as to stationing of new structures and their quantities. If any new items are included in the order it is important that laboratory control be maintained immediately by the submission of samples. No work shall be performed according to the provisions of the order until approved by the Contractor, the Division Engineer, the State Highway Engineer and the Bureau of Public Roads.

1.23 Extra Work Orders Extra Work Orders (Form No. 12) are designed to cover work for which there is no contract price as in the case of an A.W.O. submitted and later entered in the contract by a Supplementary Agreement (See Par. 1.22). They differ, however, in that the Extra Work Order is an authority directed to the contractor and the control of the work is largely on a force account basis. Generally speaking, an Extra Work Order is issued to cover work not included in the contract, which upon completion is not a lasting or integral part of the project as originally designed as, for example, the removal of pole lines, fence lines, old buildings, the maintenance of detours and the preparation of an existing roadbed for surfacing courses. The substance of the instructions following, Par. 1.231, Par. 1.235 will apply in the preparation of the front of the order.

1.231 Discussion Discuss the details of the order as per Par. 1.221, with special consideration being given the possibility of performing the work under the provisions of a supplementary agreement, the latter control being preferable if conditions warrant. Consult with the contractors as to wage scales and rental costs and secure his estimate as to the probable final cost of the work proposed.

1.232 Headings (See Par. 1.222).

1.233 Description and Specific Instruction As in the preparation of an A. W. O., careful consideration should be given the description of the work proposed. Check with the Standard Specifications, Par. 9.4, to see that the demands contained therein are answered in all respects. Show the extent and specific location of the work along with a probable schedule to be maintained by the working force.

1.234 Items The description of the work proposed with fitting explanations and tentative procedure outlined will be the basis for itemizing costs. The estimate of costs should be rendered on a feasible basis and well supported by the explanation in the body of the work order.

1.235 Submission Two copies of the order will be made in the field; the original to be forwarded to the Division Office for check and approval. The Division Office, providing ap-

proval is granted, will forward five copies of the order to the Headquarters Office for final action.

1.236 Control Ordinarily Extra Work is performed on a force account basis and the control of the work evolves into a matter of checking time and materials. It is presupposed that the work is outlined in the Work Order in such a manner that the Project Engineer will not have to render assistance in the supervision or prosecution other than to make suggestions in the interests of economy. In checking the accounts, do not adopt a "pussyfooting" attitude to the detriment of future relations with the contractor. In case the work is performed on a lump sum or agreed basis, demand the degree of perfection asked in the order. As in the case of A.W.O's., no work is to be performed until the work order is approved by the Contractor, the Division Engineer, the State Highway Engineer and the Bureau of Public Roads.

1.237 Compensation On completion of extra work, the contractor will present a statement to the engineer to include all expenditures for salaries, rental, and materials, the latter to be supported by receipts. The statement will then be assembled on the back of the original E.W.O. in the form shown herewith, special attention being given the allowances for Industrial Accident Insurance, Public Liability Insurance and Performance Bond. The Extra Work Order will then be presented with supporting receipts as a part of the Final Estimate for payment. Allowances for extra work performed during the course of construction will be shown only on the Final Estimate.

Example of E.W.O. itemization:

MATERIAL

..... @ (unit cost) = $

..... @ (unit cost) = $

Sub-Total ..... xx.xx

Plus 10% for Material Costs ..... x.xx

SUB-TOTAL MATERIALS ..... $ xx.xx (m)

LABOR

Year
Month Date Classification No. of Hrs. @ rate = $
Month Date Classification No. of Hrs. @ rate = $

Sub-Total ..... xxx.xx(a)

Plus 15% for Labor Costs ..... xx.xx(b)

Plus Industrial Acc. Ins. Code No. @ rate ..... xx.xx(c)

Plus Public Liability & Prop. Damage Ins. @ rate ..... xx.xx(d)

SUB-TOTAL LABOR ..... $ xxx.xx (n)

EQUIPMENT RENTAL

Equipment (fueled) No. of hrs. @ rate = $
Equipment (fueled) No. of hrs. @ rate = $

SUB-TOTAL EQUIPMENT RENTAL ..... $ xxx.xx (o)

Sub-Total (m+n+o) ..... $ xxx.xx (x)

Performance Bond ..... x.xx (y)

TOTAL COST ..... $ xxx.xx (z)

NOTE: (b) is 15% of (a); (c) and (d) are based on (a) less cost of team hire.

If performance bond is 1%, $(z)=\frac{(x)}{0.99}$ then $(y)=(z)-(x)$.

1.238 Poles The cost of moving poles, where a proper charge against a project will be controlled in Extra Work Orders. The preliminary estimate will be prepared on a force account basis and the final payment will be made on the basis of actual expenditures for labor and materials. Paragraph 9.4 of the Standard Specifications will bear in all matters pertaining to the work as applying on plus percentages for labor and materials.

1.24 Supplementary Agreements Supplementary Agreements, their purposes and their preparation have been described under other headings. See Par. 1.22. The field work involved is concerned with the preparation of the A.W.O. upon which the agreement is based. The costs shall be based on similar work in the vicinity or on experience with work of similar nature. In itemizing the work on the order, each unit price shall be designated as "Agreed Price."

1.241 Scope It is preferred, where conditions warrant, that a supplementary agreement be effected rather than an E. W. O. A specific instance being to cover expenses incident to the removal of a minor pole line wherein the cost is relatively easy to estimate.

1.25 Detours Detours, as needed to expedite construction work and to accommodate traffic will be prepared and maintained under the provisions of an Extra Work Order. Detours are a source of constant adverse comment and the following standard procedure will be adopted to forestall criticism:

1. Prior to the time the detour is put in use, prepare a sketch map showing mileages and tentative signing for the inspection and criticism of the Division Engineer.
2. On the Division Engineer's approval and by the authority granted in a letter therefrom, the detour will be prepared for use, special emphasis being placed on the proper location of signs. "Detour" signs, Standard CS4, will be furnished by the Commission, the contractor to erect, supply such materials as are stipulated on the Standard, and maintain them under the supervision of the engineer.

"Road Closed" signs, Standard CS2, will be furnished by the Commission, these to be erected and maintained by the contractor at each end of the work to be closed to traffic; panels, posts, strips, and reflector buttons will be furnished by the contractor. Warning signs will be erected to signify the beginning of the detour; Standard CS3 denotes the size and division of costs incident to the erection of these signs. In addition to the "Road Closed" sign on the barricade, a "Detour" sign will be placed thereon to indicate the direction of the detour.

If the detour is of great length or it is probable that it will be in use for some time, the routing should be further distinguished by the use of standard highway markers as shown below.

(TEMPORARY)
(U. S. SHIELD) Giving Federal Highway Routing.

These signs will be furnished by the Commission and will be placed on the barricades and at intermediate points as needed.

3. Before opening the detour to traffic the Division Engineer will be notified in writing as to the date the detour will be opened and the probable duration; this information to be conveyed to the newspapers and travel agencies.
4. Daily inspection trips will be made over the detour to see that all signs are properly maintained and that lights are placed on the barricades and warning signs. Reports on the condition and use of the detour will be included in the weekly news letter.
5. When a detour is to be discontinued, such information will be conveyed to the Division Engineer for the convenience of the newspapers and travel agencies. On resumption of traffic along the highway all signs appertaining to the detour will be removed and stored to prevent any possible misdirection of traffic.

1.26 Traffic Protection

If, in the course of the work no facilities are available for detouring traffic, safety measures will be adopted. Flagmen will be stationed at all hazardous points and precautionary signs; Standard CS1, will be erected at each end of the project, with the length of the project shown thereon, and a general description of the conditions to be encountered. Warning signs and

lights are to be used in liberal quantity, particularly at points where structures are being installed and turnouts are involved.

1.27 Relations With Contractor

Agreeable relations should be maintained at all times with the contractor. Enforce commands as dictated in the specifications in a manner that is friendly and impersonal rather than surly and overbearing. Do not criticise the contractor's methods or equipment, unless the results obtained or anticipated are in conflict with the specifications. The specifications do not cite any exact number of men to be employed in any operation incident to construction work and it is not within the province of the Project Engineer to order or demand that a certain number of men be employed. The control of this feature of the work is dependent on the premise that the work be carried on with a sufficient number of men to guarantee compliance with the specifications as they relate to workmanship and general efficiency. Render engineering assistance to the contractor as needed and immediately upon his call. If there is contention in the interpretation of the specifications, affect a solution by arbitration rather than argument. Refer all matters of dispute to the Division Engineer for settlement.

1.28 Relations with Public

The Engineer should prosecute his work as it affects the public along the lines dictated by courtesy and common sense. Do not discuss the policies of the Commission, but rather in your actions and conduct, reflect the character and guidance of that body.

In the conduct of their personal affairs, employees are expected to pay their current bills promptly, and should it be necessary for creditors to resort to Headquarters or legal action for the collection of same, it will be considered sufficient cause for immediate dismissal.

1.29 Relations With Other Departments

Cooperate with other departments within the organization in a manner that will promote harmony. Constructive criticism will be welcomed in all matters pertaining to the design and other affairs incident to road building.

1.30 Instruments The Engineer is charged with full responsibility for the care of State-owned equipment assigned for his use. On receipt of an instrument, whether new or old, inspect it carefully and note the condition. Notice of the receipt should then be forwarded to the Division Office to include the manufacturer's name, the serial number, the condition of the instrument, the date received, and an inventory of other equipment consigned with the instrument. Similar notices will be submitted if an instrument is transferred to another party.

1.301 Shipping All instruments shall be shipped by express and insured in the amount of their original purchase price. The instrument shall be packed carefully, paper being placed around the instrument in its case and then the case enclosed in a padded box.

1.302 Cleaning If, in the prosecution of construction work particularly on grading, the instrument begins to bind and fret due to dust entering in and around the spindle and plates, the instrument shall be taken apart and cleaned as follows:

a. Run the lower tangent screw out until the point is hidden;
b. Remove the bottom cap with the plumb bob chain and unscrew the bottom nut with a spanner wrench;
c. Lift the telescope, together with plate and limb vertically;
d. Remove lower clamp;
e. Separate the limb and socket from the plate and spindle by removing the plate tangent screw bracket and pull the plate and limb apart, exercising great care that no damage be done to the graduated edges of the limb and verniers;
f. On completion of dissembling, all parts shall be cleaned with gasoline or naphtha and wiped dry with a clean cloth that is entirely free from lint. Clean all screw threads with a toothbrush and dust off the upper part with a dry varnish brush, being careful not to touch the lens.

1.3021 Lubrication All contacting parts on completion of cleaning should be treated with a lubricant of watch oil, one or two drops of oil being sufficient over each bearing. Lubricants

should be applied only to parts that are clean and must be wiped off exposed parts to preclude the possibility of dust collecting thereon. Leveling screws are exposed and therefore subject to wear; lubrication should be supplied in the form of vaseline or a good grease in small quantity. Clamp and tangent screws, together with the spring plungers, should be oiled as hereinbefore described for bearings.

1.3022 Telescope Moisture will condense on lenses when moved from a cold place into warm air. This moisture should be removed with a chamois or cloth which is free from lint. If the fogging is between the flint and crown glasses of the objective lens, the instrument should be allowed to remain for a short period of time, in the sun or in a warm, dry room. If moisture has collected on the inside of the telescope, the eyepiece should be removed and after the open end has been covered with a cloth, the telescope should be left in a dry room until the moisture has evaporated. Inspect the objective lens frequently to see that the lens fits tightly into the setting and that the setting is fitted securely in the slide. On receipt of an instrument, the engineer should see that the lens setting is secure and if there are no marks to indicate the proper setting he will inscribe a line from the setting to the slide. If the lens is then removed for cleaning it can be restored to its original setting when the lines on the setting and the slide coincide.

Dust should be removed from the objective and eyepiece lenses with a soft camel's hair brush. Do not touch the lenses with the fingers or allow oil or grease to accumulate thereon. Lenses should be cleaned with a soft chamois or soft tissue paper. If the lenses are very dirty and have grease on them, alcohol should be used sparingly to cleanse them.

The objective lens should be covered with the cap and the eyepiece shutter closed when the instrument is not in use.

1.3023 Cross-hairs Cross-hairs should not be disturbed and it is not necessary, ordinarily, to touch them, except possibly to remove flecks of dust. This can be effected by fastening a single fine human hair to a match or a toothpick and then brushing the crosshairs to remove the dust. If the crosshairs are broken, order a new reticule complete with crosshairs for replacement. To remove the

reticule for replacement adhere to the following directions:

a. Remove the eyepiece and the two capstan head screws at the side of the telescope which hold the reticule ring;
b. Turn the ring until it is in the same plane as the line of sight. Insert a small stick in one of the screw holes in the side of the reticule, remove the top and bottom capstan head screws and withdraw the crosshair ring from the telescope. The new reticule would then be placed in the instrument in the reverse procedure.

1.303 Compass No efforts should be made in the field to adjust the compass. Care should be taken in storing the instrument that the needle will lie in the magnetic meridian to retain the magnetism for a longer period of time.

1.304 Tripods Tripods are subjected to rough usage and the maintenance necessary for their upkeep is important. The threads on the tripod head should be kept free from dust and grit. It is essential that the protective plate be replaced on the head immediately after the instrument is removed. If, due to sand or grit present in the threads, the transit "freezes" to the head of the tripod, do not use a chisel or hammer to separate the units, but rather, follow the steps outlined below:

a. Loosen all four leveling screws, raise one leg of the tripod a few inches and rotate in all directions slowly, meanwhile exerting pressure with the hands to loosen the instrument.
b. Wind a heavy cord or light rope around the tripod plate under the knurled edge and slide it back and forth rapidly to generate heat and expand the plate.
c. Remove the tripod legs, then take out the small lock screw in the half ball nut and then the half ball nut to remove the tripod plate from the transit. The tripod plate should then be tapped lightly with a piece of wood which will permit its being removed from the tripod head.

The tripod legs should be checked to see that the shoes fit securely and that the protective varnish or shellac is in a condition that will prevent weathering. Tripod bolts should be loosened at the end of each days work and during rainy weather.

1.305 Transporting In transporting an instrument by car, it should be carried in its case on the seat or on someone's lap. A padded compartment box for instruments inside the car is suggested as another means to store the instruments in transit. When placing the instrument in the case, see that all clamps are tight and that the leveling screws exert equal pressures on the plate. When carrying the transit over the shoulder, have all clamps loose, so that in case of accident there will be some "give" to the instrument.

1.306 Adjustments In making adjustments, care should be exercised to exert firm, gentle pressures. If the adjustment involves the use of counteracting manipulations, regulate them so that they will be equalized. Harger and Bonney Handbooks contain all steps necessary in the adjustment of an instrument and the engineer is referred thereto for guidance.

1.307 Usage With proper care and use an instrument will afford accuracy over a long period of time. The usage in the field should be controlled by the following precepts:

a. Set the tripod head as nearly level as possible prior to leveling up, the pressures on the leveling plate will then be equalized.
b. Place one set of the leveling screws in the same plane with the line of sight to avoid minor maladjustments.
c. Set the tripod legs in such a manner that no strain will be transmitted through the plate to permit "traveling."
d. Use a low set-up and work from the side of the instrument rather than from behind it.
e. If an instrument is damaged in use, ship it immediately for expert repair. Do not continue to use it as this will tend to increase the damage already done, to the detriment of the field work.
f. Make a firm "set-up" and use foresights to guarantee accuracy.
g. In running levels, use equal foresights and backsights to eliminate minor maladjustments.

1.308 Inventory From time to time as requested from Headquarters, the Engineer will be asked to submit an inventory (memo form) to include the description and condition of all instruments in his possession.

1.31 Expendable Equipment Rods, range poles, chains, metallic tapes, office equipment, hand levels, axes, mauls and other items of similar nature constitute expendable equipment in that their life in the field is not anticipated to be long and further, they are not considered a part of the capital assets. To prolong the use of this equipment and effect material economies, their care and use will be outlined for compliance:

a. Rods—In transporting rods, protective covering will be provided. During use in the field do not jam the rod through snow and ice. In preparing the rod for use do not jerk the rod to fit it in the clamp.
b. Range Poles—Provide protective covering when in transit. Restore the paint to prevent weathering. Do not use as a lever to pry rocks or timbers and do not throw the range pole from one member of the party to another.
c. Chains—In using the chain on a traveled road, keep it lying along the centerline to avoid traffic. If offset stakes are to be set, use a metallic tape rather than drag the chain across the line of traffic. If the chain gets wet, dry it off before rolling it up and treat it occasionally with a lubricant to prevent rust.
d. Metallic Tapes—Do not drag metallis tapes over any great distances. Wrap them up immediately when through with them.
e. Office Equipment—Including drafting tables should be given treatment similar to that extended furniture in the home.
f. Hand Levels—Care for hand levels should be similar to that given wye levels.
g. Axes—Keep a good edge on the axe. Use it for its intended purpose, not to dig holes or cut nails. Do not use the axe to pound frost pins.

1.32 Mobile Equipment The care and use of cars should be considered one of the chief responsibilities accepted by the engineer. Competent mechanical work and advice will be tendered from the Maintenance Department in the several districts throughout the State. When cars are not in use over a protracted period of time, this fact should be reported to the Division Office so that the equipment can be taken off insurance.

1.33 Note Books Separate construction note books shall be kept for each project under the general headings set forth in the project Agreement. The notes shall be recorded neatly, the pages numbered and indexed and all dates and parties responsible noted at the top of the right hand page.

1.331 Segregation The notebooks will be compiled and indexed under appropriate headings befitting the work under way. Loose leaf notebooks shall not be used on construction work. Generally speaking the notes will be classified according to the following headings:

a. Grading: To include the staking notes and the remeasurement notes;

b. Structures: To include the staking notes and sketches;

c. Alignment: To include the transit notes and sketches showing reference points;

d. Daily Diary: To record the progress, salient developments, important agreements and conversations with the contractor and any other data not carried in other notebooks which might have bearing in the future should details come into dispute or the contract run over the time limit. The diary shall be written up at the close of the day to include all matters of detail. Weather conditions shall always be noted.

e. Surfacing: To contain the daily record of material delivered and placed on the roadway. The engineer or inspector should study the possibilities of combining some of the classifications under one cover. When this has been effected, the project number, book number and classification will be inscribed on the back of the book for convenience in filing at the Headquarters Office.

1.332 Indexing Each book, when classified will be indexed, three pages being left at the front of the book for the purpose. The first page will be used as a title page to show the number of the book, the number of books compiled, project name and number, station to station intervals and the dates on which the work was started and completed.

1.333 Field Use All computations in the notebooks shall be initialed by those responsible and all work checked shall also be initialed to signify the fact.

1.334 Filing On completion of work and the submission of the final estimate all notebooks shall be sent therewith to the Headquarters Office for filing.

1.34 Computations All computations shall be recorded insofar as is possible on Form No. 16 provided for the purpose. If this form is not suitable for the computation of quantities, use other forms of similar size. The computations will be cross-referred to the field notes upon which they are based. The computations will be submitted to Helena with the final estimate under one cover and properly indexed.

1.35 Plans As Built Three black and white prints of the plans will be furnished the Project Engineer upon which he will note all changes on construction. The changes will be noted in red drawing ink or water color. All "plans as built" will be sent to the Division Office, one copy to be retained there and two copies to be sent to the Headquarters Office, one of which will be sent later to the Bureau. The changes noted shall be checked thoroughly and shall be supported by the data in the notebooks and the computations.

1.351 Alignment If changes have been made in the alignment inscribe the resultant change in the curve data and bearings. If equations are changed, show the change on both the alignment and the profile. If no change has been made in the alignment indicate this by small checkmarks on all curve data and bearings. Show all changes in length in the heading provided on the summary and title sheet. Reference points, project markers and right of way pins will be shown on the plans according to any chosen legend for convenience in reestablishing the line.

1.352 Structures Changes in length, location and classification of all structures will be shown both on the plan and summary, changes in quantities of any component part of concrete or wood structures will also be noted on

the summary, but changes in structural excavation quantities need not be shown. If no change has been effected, indicate by a check mark.

1.353 Surfacing Ordinarily no changes develop on gravel surfacing and oiling other than in the quantities. If changes are so effected, cite them on the summary sheet.

1.36 Completion

1.361 Conditional Release The satisfactory conclusion of all business pertaining to a project is contingent on prompt field action, time being an essential factor. As the various phases of the work, namely grading, surfacing and the installation of structures, are advanced to completion, notice thereof will be tendered the contractor on "Conditional Release Form No. 139." These releases are not to be construed as a formal acceptance of the items mentioned on the notice; this remains for the Division Engineer. However, the Project Engineer is charged with tentatively accepting the items under the classifications of the work to establish the contractor on a well defined basis, i. e., knowing these features are complete to the engineer's satisfaction he can schedule his work along a specified routine for the balance of the contract. The responsibility for acceptance of the integral parts of a contract rests with the Project Engineer and the release should be tendered only after careful consideration of the Standard Specifications and the plans. Damages to the roadway or the structures, sustained through cloudbursts or other uncontrolled detrimental action, after the Conditional Release were issued would be considered as contingencies and so treated when the work is restored to an acceptable status. If, however, a Conditional Release were issued and repairs and improvements were effected thereafter, which could easily have been foreseen, the resultant confusion and increased cost to the contractor would be blamed on the engineer's lack of foresight or even deficient knowledge of the specifications.

1.362 Formal Acceptance Formal and final acceptance of a project by the Division Engineer constitutes the certification of the Project Engineer's Conditional Releases in whole. If the project has been efficiently administered, the acceptance would be confirmed by wire to the Head-

quarters Office on completion of the field inspection trip. The Division Engineer should be advised shortly before the tentative date set for the completion and arrangements made for the inspection.

1.363 Time Extensions The necessity of immediate acceptance of a project is obvious when a contract has run over the time limit. In this case the Project Engineer will prepare a report for the Division Office citing the reasons contributing to the delay. The report should be substantiated by comments in the diary relative to weather conditions, lack of equipment, organization, etc. In this connection, it is recommended that the engineer keep a graphical record of the progress on the project and advise the Division Office when any delay is perceptible. On receipt of the report the Division Engineer will combine it with his knowledge of the work and make his recommendation as to enforcing the liquidated damage clause.

1.364 Outstanding Claims All claims against the contractor should be referred to the Headquarters Office for filing with the Accounting Department. Claims against the Commission are to be presented immediately after the road is accepted so that the account can be closed in Helena.

1.365 Repairs Repairs if needed, on both mobile equipment and instruments shall be made before or immediately after the acceptance so that the expenses entailed can be properly charged to the project.

1.366 Notice of Work Stopping As a part of the activities incident to completion of the work, a "Work Stopped" notice should be wired immediately on cessation of work. (See paragraph 1.414) for further particulars.

1.367 Records All records, including notebooks, plotted cross sections, plans as built, computations, etc., will be sent with the final estimate to the Division Office for transmittal to Helena. An inventory of equipment, other than automotive eqiupment, shall be presented along with the final estimate.

1.368 Statistics If, in the prosecution of the work certain features of the topography necessitated changes in the standard design or standard design practice, notify the Pre-construction

Department on completion of work and the summation of quantities. This data will then recommend the course to pursue in the design of adjacent and similar projects or in the improvement of the project just completed.

1.37 Laboratory Control The Testing Department will effect the control of all materials entering into the construction of the roadway and incidental structures. Satisfactory results depend on the prompt and rigid compliance of all orders emanating in the laboratory. The engineer will be furnished with a list of samples required, prior to the time the work starts and with this as basis, no trouble should be afforded in the prosecution of the work. Laboratory control is very important and no material is to be accepted on the work unless approved for use by the Testing Engineer.

All laboratory equipment when issued to the field will be shown on subsequent inventories along with the engineering supplies. Methods of field sampling will be outlined when the manual treats with the separate items of construction.

1.38 Requisitions Requisition Form No. 46 shall be used only for office supplies, expendable engineering equipment, and repair parts for instruments. The request will be submitted through the Division Office. Repair parts as needed for automotive equipment will be requisitioned through the Division Office on Form No. 76. The form will be made in quadruplicate, three copies going to the Division Office for approval. The original and duplicate will then be sent to the Headquarters Office for further action. Ordinarily these forms will be filled out in the district shop, the parts required being estimated by the shop foreman and the distribution according to that stipulated by the engineer.

1.39 Accidents a. EMPLOYEES.
In case of accident to an employee, State Industrial Accident Board Form No. 37 shall be prepared by the employee's immediate superior and Form No. 37-A by the employee. These forms shall be mailed to the Division Office, which in turn will submit both forms with a letter of trans-

mittal direct to the Industrial Accident Board at Helena, with a copy of the letter of transmittal to the Headquarters Office. If the accident is fatal, telegraphic or telephonic report shall be made immediately to the Division Office, which in turn will notify Headquarters Office, followed by the usual written reports. The Division Engineer will be notified as to the status of the employee in a complete report and will transmit the information to the Headquarters Office for decision as to whether or not the employee shall be shown on the payroll. See Chapter X, as it treats with meritorious leaves for further particulars in this respect. All Division, Resident, and Project Engineers should have a copy of and familiarize themselves with the "Workmen's Compensation Act."

b. STATE EQUIPMENT.

The State Highway Commission has arranged for property damage and public liability insurance covering all motorized equipment. In case of an accident involving state equipment, report is to be made immediately in triplicate by the engineer on the form furnished by the Insurance Company. One copy shall be submitted direct to the Insurance Company and one each to the Headquarters Office and the Division Office. The information required in the report is rather lengthy and the details requested have a very definite bearing on the conclusion of the case. In discussing the accident the engineer will make no statements to jeopardize the interests of the State and Insurance Company. All accidents should be reported to the proper civil authorities for record in their files.

c. CONTRACTORS LIABILITY.

The contractor is required by law to carry public liability insurance to indemnify the public for injuries or damages sustained by reason of prosecution of the work, this being one of the provisions in the Specifications. The engineer will cooperate with the contractor in preventing accidents by adopting a safety first attitude in the prosecution of all features of the work.

1.40 Labor Regulations

Labor regulations are variable as the programs change, consequently no provision will be made in the manual for specific action in administering this feature of the work. Instructive memoranda and ad-

vice will be issued from the Headquarters Office for field compliance. Speedy, prompt, precise work is required in checking the weekly payrolls and preparing and submitting Federal Forms.

1.41 Correspondence, Basic Reports, Notices, Payrolls All routine communications shall be directed to the Headquarters Office through the channels indicated when discussed hereinafter. In the event that letters are sent to offices other than the Division Office, carbon copies will be submitted thereto for filing. The engineer will retain a copy of all correspondence in his files. The reports will be clearly distinguished by the project number and the subject treated.

1.411 Basic Reports a. Weekly Progress Reports will be forwarded from the field to arrive in the Division Office on Fridays. Form for compliance is recommended as follows:

Project and unit numbers; Name of Project; Contractor; Length in miles; Type or types of construction; Engineer or Inspector actually in charge of project and his mailing address; Date contract was let; Date work started; Completion date and probable completion date; The percent of each of the main contract items completed to date and the total percent of project completed; Rate of progress, whether good, fair, or poor; if poor, give reasons for same; Total number of men employed on the project and number of these who are Montana residents.

Do not show reports on projects, "Same as previously reported," unless work has been suspended, or contract completed and final acceptance has not as yet been made.

The reports should be made out and submitted in conformity with the following form:

FAP 235-H, Unit 1—Geyser-Stanford
12.101 miles—Grad. Surf. & Bit. Treatment

Contract Let Aug. 30, 1935
Work Started Sept. 15, 1935

E. A. Studer & Son, Contractors
M. E. Snell, Project Engr.
Stanford, Montana.

Completion Date July 31, 1936
Probable Completion Date July 3, 1936

Progress during the past week has been very good. Contractor has moved 21,053 cu. yds. excavation between Sta. 297/36 and 377/33, and 4200 cu. yds. between Sta. 604 and 625. The total yardage moved to date is 101,884 cu. yds., making this item 39% complete. 15″ culverts are now 6% complete, 24″ culverts 95% and 30″ culverts 40% complete. The project as a whole is 23% complete or an equivalent of 2.78 miles. Fifty-five men are employed on the project, fifty-one of whom are Montana residents.

The Weekly Progress Report submitted on the date nearest the close of the month shall show construction data in more detail and include a complete list of all equipment used on the project during the month.

b. Semi-Monthly Report of Men Employed; in memorandum form.

This report will be submitted to arrive at the Division Office on the second and seventeenth of each month. The report shall be segregated into four headings to show the Montana residents, Out-of-State residents, subheaded according to number, ex-service and supervisory, total employees and total ex-service.

c. Monthly Report of Sub-Contractors; in memorandum form.

This report shall be submitted to arrive at the Division Office on the second of each month. The report shall state whether or not sub-contractors are employed and if so, will state their names, the project number and the names of the general contractors.

1.412 Inventories

a. Monthly Equipment Inventory, Form No. 28.

These inventories will be submitted to arrive in the Division Office on the third of each month.

b. Monthly Statement of Mileage, Form No. 113.

The original and yellow copy of this form will be sent to arrive in the Division Office not later than the third of each month. The data contained in the report shall apply on work financed in whole or in part with Federal funds.

c. Engineering Equipment Inventory (Standard letter or memo).

This inventory will be submitted when requested from the Division Office to include all instruments, rods, hand levels, chains, etc., along with any laboratory equipment.

1.413 Bureau Communications

The Bureau of Public Roads provides forms upon which the Project Engineer will report the number of men employed on construction work, their status on the contractor's payroll and other features of similar nature. These reports are contingent on the Special Provisions appended to the Standard Specifications as they relate to the regulation and employment of labor on contracts awarded under the Emergency

Programs or regular Federal Aid Programs. Inasmuch as the forms and the methods of submitting them will change with the programs, the manual will not treat in detail with Bureau communications; instructive memoranda will be issued from the Headquarters Office relating to the proper procedure in submitting these reports.

1.414 Conditional Reports and Orders

a. Work Starting.

Telegraph the Division Office advising that the work started. The form of the notice will be as follows:

"Work on project (give number and unit) started (date) with (number) men employed." The Bureau of Public Roads will then be advised by wire from the Division Office and a copy of the wire will be submitted to Helena. In cases where two or more units of the same project are included in one contract, all the work in the contract will be treated as an independent unit insofar as the notice of beginning work is concerned.

b. Shutdown Orders.

Shutdown orders will be issued by the engineer to the contractor when work is closed down for the winter months. The order will be issued in quadruplicate, the original to the contractor, one copy to the Headquarters Office, one copy to the Division Office and one copy to be retained in the field.

c. Temporary Shutdown.

The Division Office and the Headquarters Office shall be notified of the shutdown giving date effective and number of men released.

d. Go Ahead Order.

The engineer will issue a go ahead order to the contractor when suitable weather conditions prevail following a shutdown. Distribution of the order as for a "shutdown order."

e. Work Resumed.

On resumption of work the Division Office and the Headquarters Office shall be notified immediately giving date effective.

f. On completion of a project the information would be wired to the Division Office. The form and distribution would be similar to that used when "work

started," the information conveyed would, of course, be conversely opposite. If two or more units of the same project are combined in one contract, the time of completion for the project would be governed by the unit completed last.

1.415 Engineering Payroll

Engineering Payrolls, Form No. 31, are to be prepared as of the 15th day of each month by the field engineer. Two copies are to be forwarded to reach the Division Office by the 17th day of the month for check and approval. The Division Office will check the classification, rate, time and distributions from the personnel cards and notices of transfer, release, etc. The payroll shall show if the employee is newly employed, reemployed or released, and the dates effective in each case. When an employee is transferred, the payroll shall show from whom and the date, as well as to whom and the date. If an employee's rate is changed, his name and time should appear once for each change showing the dates effective. In all cases, the classifications shown on the payroll should agree with those shown under the "Classifications of Employees and Uniform Wage Structure." Should three or more men be released at the same time prior to the regular payroll date, a payroll on the standard form and marked "Supplementary" shall be prepared and submitted through the regular channels, rather than submitting claims for each individual. Any employee who has been paid by State claim shall be so listed on the payroll.

For convenience and ease in checking at the Division Office the following recommendations are presented for compliance.

a. Chief of party to appear at the top of the payroll.

b. Use two lines for each employee, for as many times as he appears on the payroll at different rates and classifications.

c. All persons other than the Chief of Party shall appear on the payroll in alphabetical order.

d. Do not extend the payroll to show the distribution by projects.

1.416 Transfers

All transfers shall be noticed to the Division Office on the form provided, to show the date and the direction of the transfer. Ordinary Transfers are as follows:

a. Personnel—Three copies, one each to the Division

Engineer, the Accounting Department and the Personnel Department. See Chapter X for further particulars.

b. Equipment—(Motorized) Three copies, one each to the Division Office, the consignee and one to the field files. The transfer will show the mileage, the date, and the equipment transferred according to Highway number and type.

c. Instruments—Three copies to show the date, the serial number, type of instrument and the consignee.

d. Miscellaneous—All equipment and supplies shall, when sent back to the Division Office, be properly noticed thereto.

1.417 Notice of Receipt All transfers when effected shall be noticed to the Division Office on receipt by the consignee. The form and subject matter to conform with the notices of transfer.

1.418 Samples All samples submitted to Helena will be reported on the forms provided by the laboratory, the original copy going direct to the laboratory, the duplicate to the Division Office and the triplicate being retained in the field, (unless modified by subsequent instruction in the manual). The reports from the laboratory will be distributed to the field from the Division Offices.

1.419 Road Logs Road logs will be submittel on or before completion of a project to show the distance along the new route as compared with the distance along the old road. The distance along the old road will be measured by speedometer, care being taken that the speedometer is properly calibrated. The distance along the new road would be taken from the construction plan length. The report would be submitted through the Division Office to Helena.

1.42 Prohibiting State Owned Equipment Contractors are prohibited the use of State-owned equipment on Public Works Highway Projects. The prohibition extends also to County and City owned equipment. If the contractors choose to use equipment coming under the latter category, the matter should be reported immediately to the Division Office. A thorough and complete record must be kept of the amount expended in rental. The record will then

be transmitted to the Helena office for referral. The practice is not to be justified by any circumstances as the Bureau will deduct the rental amount from the Federal funds due the State.

1.43 Photographs Any unusual features of the work should be photographed. "Before and After" pictures of the improvement are of value in recording the history of the work. Any view of scenic value, showing the road, but not accentuating the details of construction should be submitted for possible use by the Headquarters Office.

Photos are of considerable value when taken to present any feature of the work which is liable to come into dispute. This is especially true in cases involving Right of Way.

The Field Engineer will be reimbursed for any reasonable expenses incident to taking the pictures on presentation of claims and the receipts for the expenditures.

1.44 Expense Accounts In most cases the employees in the Construction Department will be assigned to work of such duration that they can establish a residency and consequently will not be allowed any part of their personal expense. If, however, the engineer and his assistants are assigned to work of a special nature and short duration, expenses up to the legal limit ($4.00 per diem) will be allowed at the discretion of the Division Engineer.

1.441 Claims Personal expense claims must be submitted immediately after the close of the calendar month and shall include only actual and necessary expenses. Receipts for all expenditures over $1.50 and for all lodging expenses shall be presented to substantiate the claim.

1.45 Right of Way Department The Right of Way Department, under the direction of the Pre-Construction Engineer, serves to complete all negotiations for Rights of Way, borrow privileges, and other related permits and easements occasioned by construction work. Recognizing this fact then, the Project Engineer shall refer all matters within the province of the Right of Way Department to the Pre-Construction Engineer for consideration and conclu-

sion. As cited before, Paragraph 1.201, the Project Engineer is charged with the satisfactory consummation of all Right of Way agreements, however, it is to be emphasized that he should not extend his authority to include the purchase of land; neither should he enter into agreements relating to land transfers as a representative of the Highway Commission. This work is entirely within the control of the Right of Way Department or its authorized agent.

1.451 Additional Borrow It sometimes happens that additional borrow is required, due to a line change or a grade revision; in this event make a survey to ascertain the probable encroachment and submit all notes, maps and descriptions to the Right of Way Department for responsible consideration and the preparation of required legal forms. On approval by the State Highway Engineer, the land will be purchased for use as a source of borrow. If the additional borrow is to be furnished on a cubic yardage basis, state this fact in a letter to the Department and the proper agreements will be compiled accordingly. Care should be taken that the ownership is properly recorded with a notation as to mortgages, encumbrances, etc.

1.452 Additional Right of Way Additional Right of Way if needed for additional borrow or increased Right of Way width to accommodate high fills or to avert bad snow conditions shall be purchased in a manner similar to that outlined for "Additional Borrow."

1.453 Source of Binder If binder is not available within five hundred feet of the contractor's crusher, the Commission will furnish a source for binder at its own expense. The Project Engineer will survey the site proposed as a source of binder and submit the survey data to the Right of Way Department as a basis for the preparation of the description and legal forms.

1.454 Contractor's Purchase of Borrow Special instances may arise wherein the contractor may consider it advantageous to borrow at his own expense from other sources than those indicated on the plan as a source of borrow. In this case, refer the matter to the Headquarters Office, with all pertinent data for approval and conclusion.

CHAPTER II

GRADING

2.1 Earthwork The limits controlling grading work are approximate rather than exact. The finished product shall conform to the precise lines shown on the plans, but the methods adapted to achieve the end shall be based on a proper combination of known engineering practices and clear experienced thought.

2.11 Clearing & Grubbing Clearing and grubbing as a unit is usually let as a part of the incidental cost of grading. The Standard Specifications describe the procedure very clearly, however, the sentence "Trees of value to the appearance of the road and not coming within the slopes shall be left upon order of the Engineer," should be given careful consideration. We now recognize that our highways upon completion have a very definite aesthetic value and any natural growth within the confines of the Right of Way will enhance the appearance greatly. Trees should, of course, be removed if they are so located as to create a bad snow condition or if they obstruct the rays of the sun or create poor visibility.

Brush, if left along the edges of the Right of Way, provides a protective covering for game birds and incidentally, adds to the appearance of the roadway. If, however, a bad snow condition is created, the brush must be removed.

2.2 Engineering

2.21 Alignment One of the first duties on award of a contract shall be to re-establish the located centerline, either according to the location notes or according to projections indicated on the plan. If the line is projected, great care should be exercised both in the instrument work and in the measuring. All projections should be worked from controls indicated on the plan and the blue print cross-sections. In staking the line, the engineer should anticipate that cross-sections will be required at all breaks indicated by the location notes, at all points where the roadway ditch constant changes, and at all points designated for the installation of structures. On curves,

stakes will be set according to the following chord lengths; up to 8° use 100 foot chords and up to 16° use 50 foot chords. It is not intended that the chord lengths indicated above will control the number of cross-sections taken on the curve, but rather that the intervals thus established will be the maximum distance between cross-sections. While the centerline is being staked it is important that transit points be established at or near all sites proposed for major structures. Stakes used should be 1″x2″x18″ sharpened and S2S. The stakes will be procured according to contracts existing in the several districts. If it is necessary to offset from a traveled way, the centerline will be located with small wooden plugs instead of nails with red flagging. All transit points as established on the location survey will be reset if disturbed, and in this connection the engineer should bear in mind that the limit of error on all measurements is one foot in five thousand. If there is a difference in chaining within the controlling limits, the engineer will produce the alignment from the original location data. If the difference in chaining is over the limit, the error will be taken ahead to the end of the next curve and an equation inserted at that point. If, in the course of re-establishing the survey line, it is found that there is error in the location delta angles, change the curve data accordingly and insert an equation in bearings, however, the curve data is not to be changed if the apparent error in the angle deflection is less than two minutes.

Transit points will also be established opposite any jogs in the Right of Way and at the intersection with all subdivision lines where the Right of Way lines change.

2.211 Reference Points On completion of the transit work, all important points established including the P. C's., P. O. T's., P. T's, and equations will be perpetuated by setting out reference hubs. The lines established by the hubs will intersect with an angle big enough to expedite the future re-setting of the hub. Care should be taken that the reference hubs be set in such a manner that they will not be destroyed during the course of the grading activities. When a point is re-established from a set of reference hubs, during the course of construction, the point should be placed at a depth of six inches below

the road surface and referenced by offset stakes so that if the point is needed it can be found without going to the trouble of intersecting from the reference hubs.

2.212 Right of Way Markers All jogs in the Right of Way lines shall be staked either with a 1"x18" gas pipe or a solid iron pin similar to those used for staking snow fence. The markers will be pounded flush with the ground and measured in place according to the Right of Way dimensions shown on the Right of Way map. These markers will serve as the perpetual references, to the centerline of the highway and in the case where the Right of Way line is straight, additional markers will be set at intervals convenient to re-establish the survey in the future.

2.213 Project Markers The beginning and end of the project will be marked according to the procedure outlined in the "Standards." The materials required will be furnished on request from any of the several maintenance shops.

2.214 Notes All notes pertaining to the alignment shall be entered under one cover in the form depicted in the "Standards." The notes shall show all reference points, all Right of Way markers and the data pertaining to the project markers.

Federal regulations stipulate that the location of the beginning and the end of the project shall not be changed; the stationing may be changed, and if so, proper entry should be made in the notes to show that the location of the point had not changed.

All equations shall be shown clearly to preclude any possible oversight.

The transit notes will be submitted with the final estimate data on completion of the project.

2.22 Construction Cross Sections In cross-sectioning the project prior to construction, care should be exercised to take sufficient sections to accurately outline the work. In addition to cross-sections at all full stations, intermediate sections will be taken at all P. C's. and P. T's. both on horizontal curves and vertical curves, at all sites for drainage structures and at intervals not

to exceed fifty feet on all curves and if in mountainous country, the maximum interval on curves shall be twenty-five feet. All breaks will be cross-sectioned and any point where the grade plane meets the ground at the centerline. The cross-sections will cover all the ground lying within the grading limits.

2.221 Reference Stakes The sections shall be taken normal to the centerline and it is very important that the reference stakes be set carefully, both by distance and angle.

Reference stakes will be marked to show the cut or fill from the ground at the front of the stake to the centerline grade. The stationing and offset distance will be marked on the stake to face the roadway. If in rough terrain where hand levels will be used in cross-sectioning a separate line of levels will be run along the reference line to ascertain the cut or fill to serve as a check for the hand level work. The reference stakes will be set chiefly for the accommodation of the contractor; all subsequent blue tops will be set with a level working from the ordered level datum.

2.222 Slope Stakes Slope stakes will be set at full stations and as needed to clearly define the work. All points at which the longitudinal grade plane meets the ground line will be staked as naught naught points. Any point where the transverse grade plane, when produced, intersects with the ground line will be staked and marked 0.0 and further identified as a "daylight" stake (D. L.) The cut or fill, marked on the stake (C and F respectively) will be along the length of the stake and the distance out will be marked transversely thereunder. The station number will be marked on the back of the stake. The cut or fill marked on the stake will be the difference in elevation between the ground at the stake and the next adjacent break in the typical section towards the centerline of the roadway.

2.223 Notes In recording the notes the engineer should use any standard method which will insure ease in computing the end areas, both in the staking notes and the final remeasurement notes. The following form in recording the notes is recommended for compliance.

LEFT HAND PAGE

Sta.	Grade	H. I.	—	Grade Rod	Elev.	

The column designated "Grade" will also be used to record the back sight on the bench mark or turning point. If at any point, the roadway is widened for curves, the amount of widening will be indicated at the station affected and denoted by the letter "W." The super-elevation on all curves will be shown for each station so affected and denoted "S." The notes shall not be crowded, three blank spaces being left between each cross-section. All construction cross-sections shall be recorded in order of the stationing from the top of the page down.

RIGHT HAND PAGE

Names of Party	Date Weather Conditions
Lt.	Rt.

On beginning the cross-sectioning, the typical staking sections will be drawn on this page to show the slopes, the width of the road, etc. Any changes in the typical sections will be shown at the point where the change is effected. In selecting a typical staking section, the engineer should bear in mind that a very definite crown is now required on all roads and in modifying the typical design section for ease in staking, care must be taken to provide adequate width on completion. The notebooks will be submitted with the final estimate, properly indexed and classified as "Construction X-Sections."

2.224 Grades Grades, later transcribed to the cross-section notes should be computed prior to going into the field if possible. Profile grades on all curves, and run-offs thereto, shall be carried twelve feet inside the curve on a twenty-four foot roadway and fifteen feet on a thirty foot roadway.

2.225 Computations In computing the end areas of the cross-sections; the cut areas will be inscribed immediately under the recorded cross-section and to the left of the centerline; the fill areas will be shown in a corresponding position on the right of the centerline. All computations will be certified by the initials of the party who figured the areas and when the areas are checked this also shall be signified by small check marks and the initials of the checker. The calculated end areas will then be transferred to the computation sheets (Form No. 16) and extended to quantities. The shrinkage factors used in the design will govern tentatively on the construction. If a balance can be effected to coincide with the balance shown on the plan by changing the shrinkage factor slightly, do so, rather than carry the difference through the project. If the balance changes, advise the contractor so that he can adjust his hauls. Mass computations will be plotted and calculated through each set of thirty stations ending on a field station number evenly divisible by thirty. The computations and mass diagrams prepared as shown will be the basis for all estimates prior to the remeasurement.

2.226 Plotted X-Sections All cross-sections shall be reduced to elevations and plotted on the thin cross-section paper provided. The plotting shall be laid out in such a way that on completion of the project the roll can be cut in thirty-six inch sheets. A margin of three inches shall be provided on the left end of the sheet. The sections shall be plotted up the sheet beginning on the lower left-hand corner. The staked section will then be drawn in and the elevations or co-ordinates, depending on which will be used in computing the final areas, will be noted along the ground line.

2.23 Blue Tops Finishing stakes shall be set on completion of the rough grading. The centerline shall be re-established by transit rather than from reference stakes and the grades set with a level. All estimated shrinkage will be staked on the blue tops, due consideration being given the fact that the roadway has been compacted somewhat under construction. In addition to the blue tops set on the shoulders, finishing stakes will be set at all other breaks as shown on the typical section, to guarantee true lines and good drainage along the side borrow pits.

All notes pertaining to blue tops will be recorded in a separate notebook, properly indexed and classified "BLUE TOPS", to be sent to Helena with the final.

2.24 Remeasurement On completion of any portion of the work, remeasurement cross-sections will be taken immediately. These final cross-sections shall be taken at all points where an original cross-section was taken and at all other places where necessary to accurately define the completed roadway. The notes shall be recorded in a separate notebook, properly indexed and classified as "Remeasurement Notes."

2.241 Finished Ground Line From the remeasurement notes, the finished sections will be superimposed on the plotted original ground line and the staked sections in red pencil. The final elevations or co-ordinates will be noted and the end areas computed. The final areas will be noted immediately below the plotted section, cut area to be one inch to the left of the centerline and fills one inch to the right. On completion of the final computations, the sheets will be bound in lengths of thirty-six inches and identified as "Final Cross-Sections" for submission to the Headquarters Office.

2.242 Final Computations The final end areas shall be transcribed on computation sheets (Form No. 16) and the yardage computed. These computations shall be identified as "Final Computations," and similar to the construction computations will be made up in sets of thirty stations. Shrinkage or swell will be computed in such a way that the balance points will concur in stationing with the actual field construction balance points established during the grading work. All quantities between all balance points will be entered on the computation sheets. The stationing of the balance points will also be noted thereon. The computations will be submitted to Helena under one cover with the final estimate.

2.243 Final Mass The final mass diagram will be plotted on thirty-six inch sheets, a three inch margin being allowed on the left and the right end of the sheet. The yardage and the overhaul will be shown thereon in a form similar to that used on the design diagram. The sheets will be bound with the cross-sections for submission to Helena.

2.25 Estimates Headings are provided on the estimate form for listing the excavation and overhaul quantities. All quantities to date will be listed for each estimate.

2.3 Borrow Side borrow as now designed, constitutes a part of the roadway. Other borrow, outside the limits of the roadway, shall, if extending longitudinally adjacent to the road, be cross-sectioned with reference to the center line stationing. If the borrow pit is a considerable distance from the centerline of the highway it would be staked as a separate unit, with ties, however, to show the location. Borrow pits of any great extent on the inside or the outside of curves should be staked as a separate unit, with no reference to the centerline stationing other than the ties. In laying out the pit, the engineer should anticipate the probable lines of excavation and reference the base lines so that they can be re-established for the final remeasurement. Adequate original cross-sections will be taken to show the ground in its original position. Final cross-sections will be taken at the points originally cross-sectioned and other points as needed. If there is space in the "Construction Cross-Sections" notebook, the notes covering the borrow can be entered therein and the final cross-sections can be entered in the "Final Cross-Sections" notebook. If borrow is used in sufficient quantity on the project, enter the original cross-sections and the re-measurement under one cover and classify as "Borrow." Similar distribution will be used for the computation sheets.

2.31 Borrow Control Borrow pits when used, are in many cases subject to regulation under the Right of Way agreements, and any stipulations set forth therein shall be followed to the letter. Other features to be observed are as follows.

a. Regulate the contractor's work so that his equipment will move back and forth across the face of the pit. On completion of the work then, there will be no gouges and the slopes can be trimmed to present a neat, symmetrical appearance.

b. Do not allow spoil banks on top of the slope.

c. If possible, do all roadway excavation prior to using borrowed material, to avoid any chance of waste.

2.4 Channel Changes Channel changes shall be staked and measured with the same degree of accuracy as for the work on the roadway. The notes and computations will be distributed as outlined for borrow pits.

2.41 Channel Changes Control In making channel changes, the engineer should endeavor to use all excess excavated quantities in embankment and where feasible, this work should be performed prior to the roadway excavation.

2.5 Road Approaches All road approaches constructed should be built to the maximum width provided in the plan.

2.6 Waste Waste is to be avoided. If any special advantages are to be gained by raising the grade, do so; if not, scatter the excess material uniformly along the shoulder of the roadway. If in mountainous country, provide turnouts and parking places for the convenience of traffic.

2.7 Roadway In grading, it is well to remember that the mass diagram is worked up on assumed swell or shrinkage factors and that any haul or statement of quantities given is subject to change in the field. The work of putting up a subgrade is primarily that of providing a foundation for subsequent surfacing courses, hence the engineer should maintain a close check on the materials entering the roadway. Adverse soils which exhibit large changes in volume with varying water content are usually unstable when exposed to atmospheric action; accordingly, such soils should be buried deeply in the fills and if present in cuts should be removed to a depth of six inches and replaced with acceptable material.

All fills immediately adjacent to structures shall be laid in horizontal layers of twelve inches to guarantee compaction and thus forestall later settlement.

In rock cuts the excavation will be carried six inches below the finished profile grade line. In doing this, care should be taken that no pockets are created to thus allow the accumulation of water.

2.8 Drainage

All borrow pits and side ditches should be checked to see that an adequate runoff is provided for surface water. Inlet and oulet channels should be provided at all drainage structures. In no case should there be "dead" water in the vicinity of the roadway as this will provide a source for capillary action and resultant "frost boils."

At any point where the roadway emerges from a thorough cut, the ditch constant should be increased to present a funnel appearance and thus direct surface water away from the fill slopes.

2.9 Slopes

The lines staked to define the slopes are to be followed by the contractor. Do not allow excavating equipment, particularly shovels, to under-cut slopes; this can be avoided by working the shovel along the side of the cut face. If there is under-cut along the slopes and consequent waste, advise the contractor that no remuneration can be allowed for the quantities taken out below the slope lines. All slopes when completed should present a neat and firmly bound appearance.

A three foot berme should be left between the top of all cut slopes and the Right of Way line.

2.10 Finishing

Finishing should be regarded as an integral part of all grading. During the course of the work, all large rocks should be concealed in the embankment; in no case should they be left exposed in the borrow pits or along the top of the slopes. It is to be emphasized that all finishing be kept up with the rough grading so that the final remeasurement can be effected immediately.

A project will be considered finished and ready for final inspection when the roadway prism, including side borrow pits, and such other borrow pits as are visible from the highway, are trimmed to present lines, well defined, true, and straight to the eye along the length of the roadway, conforming in general to the lines and dimensions shown on the typical section. Finishing should be prosecuted to gain uniformity in the grade lines and the ditch lines and the means to attain that end are based on judgment and practical thought, rather than a rigid compliance with the dimensions and precise grade elevations shown on the plans. The Project Engineer should not order such unnecessary refine-

ments in the finishing operations, which, upon completion, will not have added to the value of the road, but will have burdened the contractor with unjustified expense. Finishing may be effected by the contractor by use of mechanical equipment or by hand labor methods, whichever he may deem expedient.

2.11 Incidentals Since grading work is first in the line of improvements recommended for a highway, incidental work comes in as a necessary part of the whole. Ordinary contingencies and their treatments are as follows:

a. Pole Lines—All work pertaining to the removal of pole lines shall be paid for according to the provisions of an E. W. O. (See paragraph 1.238). To supplement the description in the E. W. O. the engineer shall prepare a sketch to show the original location of the pole line with reference to any existing public right of way and the new staked centerline. On completion of the work, the new plant layout shall be shown on the sketch also.

b. Land Monuments—All corners which will be destroyed due to grading activities shall be witnessed according to the instructions in blue print form contained in the "Standards." Only those corners which are in will be witnessed; the engineer shall not re-establish any corners that are not in place and then witness them.

c. U. S. G. S. Bench Marks—All U. S. G. S. bench marks coming within the area of the graded section shall be reset in a new location. Select a new location on the Right of Way which will not at any time be disturbed. Before disturbing the bench mark set a temporary bench from which to transfer the elevations. Remove and reset the bench mark to the new elevation, preferably to the same elevation as the original. Note carefully the direction, distance and elevation of the bench mark in the new location and send the notes to the Division Office for transmittal to the U. S. G. S.

In this connection it is well to set new benches on all major structures, culvert headwalls, etc., noting them on the "Plans as Built.'

2.12 Laboratory Control The Testing Department does not exercise control over grading work, other than to test materials encountered in construction work as a possible source for future surfacing or aggregates.

CHAPTER III

DRAINAGE STRUCTURES

3.1 Culverts and Structures Construction details of all forms of culverts are contained in the Standard Specifications and the engineer is referred thereto for compliance.

3.2 Pipe Culverts

3.21 Location Prior to staking drainage structures, the engineer should make a thorough study of the drainage requirements and the provisions made on the plans therefor. In many cases a material saving can be made by a slight deviation from the planned location. This is particularly true in ravines which cross the highway on a skew. In this case the inlet would be staked on the flow line and the drainage carried normal to the centerline and higher up the sidehill to effect a saving in length. Ordinarily, drainage structures as designed are adequate, having been recommended by the Pre-Construction Department and re-checked by the plan in hand inspectors. However, if a change in waterway area is required, it should be effected only after consulting with the Division Engineer.

If a change is authorized by an A. W. O. the installation will be exactly as described in the order.

3.22 Flow Line Drains Generally speaking, a culvert should be staked to conform with the contours of the channel in which it is proposed to place the pipe. The grade should be adequate to carry all debris and silt through the pipe. The flow line of the inlet and outlet should be staked at an elevation somewhat higher than the flow line of the channel to prevent silting. This can be done by moving the culvert a short distance away from the center of the water course. Immediate runoff facilities should be provided at the outlet of all metal pipes to prevent rusting.

Pipe culverts which are to be placed in the highway in sections adjoined by side borrow pits shall be set to a depth somewhat lower than the finished grade at the toe of the backslope.

3.23 Flow Line and Length-Irrigation Irrigation pipes shall be staked to conform exactly to the grade existing in the irrigation channel. Some change may be effected in the channel to procure a right angle crossing. However, care should be taken that the new channel will carry the water in a satisfactory manner. In cases where the water is to be carried from berme to berme pedestals will be provided to support the pipe and the inlet and outlet should extend into the bank a distance of three feet beyond the top of the cut slope. If the water is being carried in a pipe under the fill only and side borrow pits are designed, the engineer should install drainage thereunder. The width of the "plug" at the top should provide for a four-foot berme on each side of the channel.

The flow line of all irrigation pipe culverts shall be staked a distance below the channel flow line equal to one third the inside diameter of the pipe.

3.24 Flow Line and General Procedure-Side Drainage Side drain pipes shall be staked after completion of rough grading. The engineer should then ascertain the flow and direction of the surface water and stake accordingly. In many cases the side drains as shown on the plans are not needed, the side drainage required having been estimated by the locator prior to the time the grade on the roadway and the borrow pit was fixed. All side drains shall be staked three feet out from the toe of the back slope. Structure excavation shall not be computed from the original ground line, but rather from the new ground line established in the borrow pit on completion of rough grading.

3.25 Pipe Lengths Pipe lengths as designed, are to extend two feet beyond the end of the roadway slopes. If the culvert is staked under a shallow fill or at a point where side borrow pits are constructed a theoretical 1½:1 slope will be computed to intersect with the proposed flow line and the additional two-foot lengths will be added thereto. The method of computing pipe lengths contained herein is subject to modification according to paragraph 3.23.

3.26 Structure Excavation Paragraph 12.4 of the Standard Specifications limits the structure excavation to a "volume bounded by vertical

surfaces, established at twelve inches outside the neat footings." In applying this limit for the measurement of structure excavation incident to the installation of pipe culverts, the extreme pay width for the volume of excavation would be the diameter of the pipe plus the width of the shell (R. C. P. culverts) plus two feet for the volume outside the neat footings. This specification also requires that the material excavated be measured in its original position and is construed to mean the position maintained immediately before the excavation work incident to the culvert installation was performed. Typical instances are as follows:

a. In a thorough cut, the lines bounding the structure excavation would extend from the flow line grade up to the staked roadway lines.

b. In a side borrow section, if the borrow had not been removed the lines bounding the excavation would extend from the staked flow line to the original ground line. If borrow had been taken out, the volume would be confined between the staked flow line and the staked roadway line.

3.27 Staking When the inlet and outlet has been located according to instructions given hereinbefore, the centerline of the culvert will be established and referenced. All breaks in the culvert line profile will be staked and cuts marked thereon from the top of the stake to the bottom of the pipe. All excavation for inlet and runoff channels will also be staked and noted as additional excavation to be paid for as unclassified excavation.

3.28 Notes All notes pertaining to the installation of pipe culverts shall be entered under one cover, properly segregated and indexed, and classified as the "Structures" notebook. Prior to staking the culverts the engineer should transcribe from the plans summary to the "Structures" notebook all pipes in the order in which they are shown. The pipes should be segregated according to the nomenclature on the plans, i. e., under headings of C. M. P. Irrigation, R. C. P. Irrigation, C. M. P. Drains or R. C. P. Drains. Sufficient space should be left between each station recorded in the book to note the cross-sections and sketch the pipe. On small projects, an effort should be made to combine the structures notes with other notes to consolidate the engineering data. Form recommended for compliance is as follows:

LEFT HAND PAGE

"Descriptios"

Plan Sta.	Plan Dimensions	Plan Excav.	Const. Sta.	Const. Dimensions	Est. Date

RIGHT HAND PAGE

The right hand page shall show a sketch of the culvert, the cross-section, the structure excavation quantity, the date the structure was installed and the grade and direction of the flow.

As a preliminary to the final estimate all structures should be listed in order of their stationing in a recapitulation at the back of the notebook. This statement should be listed to conform to the headings on the plan summary.

3.29 Estimates Basic headings are provided on page two of the estimate blank for the entry of pipe structures and structural excavation.

3.30 Laboratory Control Ordinarily all pipes are tested at the source, either by an authorized inspection bureau or a representative from the Testing Department. In any case the engineer is advised as to the quality of the material. On receipt of the pipe in the field, it should be thoroughly checked for any possible damage incurred in transit and a written report tendered the Testing Department as to the condition at the railhead.

3.3 Concrete Box Culverts

3.31 Location The same general controls will govern in locating box culverts as in placing pipe culverts.

3.32 Flow Line The flow line will be laid to conform with the contours of the water course and six inches below the level of the stream bed in both drains and irrigation canals.

3.33 Length The lengths of box culverts shall be staked in multiples of two feet. The engineer should try to effect a saving in length at all times by decreasing skew angles, or changing location.

3.34 Structure Excavation Structure excavation shall be paid according to the limits prescribed in the Standard Specifications.

3.35 Foundations The foundation should be checked thoroughly and if it displays weakness, the Division Engineer should be notified and corrective measures taken. This can usually be effected by excavating to solid ground and backfilling with gravel.

3.36 Staking The box culvert should be staked and referenced along the vertical lines which will be exposed when the culvert is completed. Procedure in the average case would be as follows:

a. From the hub at the centerline of the highway, run a line along the length of the culvert and produce it far enough to reference. Set hubs at the end of the barrel and temporary stakes one foot outside the neat vertical surface of the footings.
b. From the hubs at the end of the barrel turn the angle indicated and set hubs at the inside corner of the box and reference stakes. Set temporary stakes one foot outside the neat vertical surface of the footing at the outside corner of the box.
c. From the hubs at the corner of the box, turn angles along the inside surface of the wing walls and set reference stakes. Set temporary stakes one foot outside the neat vertical surface of the footing at the end of the wing. If the profile is irregular between the ends of the box set temporary stakes along the inside line of the barrel and then offset them to a location one foot outside the neat vertical surface of the outside of the barrel.
d. Cross-sections will then be taken and the cuts marked to the bottom of the structure. In marking the cuts on the temporary stakes, the cuts indicated on the stake shall be from the top. The cuts indicated on the centerline and end of barrel references shall be from the top of the hub to the flowline.
e. Most box culverts are laid normal to the centerline of the highway and the computation of quantities is

only a matter of figuring end areas and calculating the volumes. On skewed culverts each rod reading should be identified by a number or letter, then the box would be drawn in plan and the elevations projected therefrom to compute the quantities.

3.37 Notes Sufficient space should be left in the notes to show all work pertaining to the installation. A sketch should be provided on the right hand page showing the cuts, the references, the grade and direction of the flow and the skew angle from the highway. On the left hand page the history of the construction work would be shown, giving the name of the inspector, the dates, the materials used and laboratory acceptances therefor, weather conditions and a summation of the component parts for entry in the estimates.

The culverts should be classified according to use, i. e., irrigation or drainage. On completion of the work and computation of quantities, the culverts will be listed in the recapitulation at the back of the "Structures" notebook. (See Paragraph 3.28).

All notes hereinbefore described shall be entered in the "Structures" notebook according to the classification of the structure. (See Paragraph 3.28).

3.38 Concrete and Steel The Standard Specifications, Sections 26, 27 and 28, define the limits controlling all concrete work on box culverts and the engineer is referred thereto for rigid compliance. The following suggestion is advanced to aid in conforming to the specifications:

3.381 Aggregate Proportions Aggregates should be combined to present the densest mix possible with the materials at hand. The testing laboratory is equipped to determine the percentage of voids, the specific gravity and the weight per cubic foot of all samples submitted. To aid in the field design of the mix, the engineer should request an "ideal mix" from the laboratory when submitting samples of stock piled aggregates. On receipt of the sample report Form No. 47 from the laboratory, the engineer would then design the mix according to the data on the report, to come within the limits prescribed by the "Master Proportion Table" on page 41 of the Specifications. The weight can be modified up to 6% for fine aggregate and 2% for coarse aggregate to

compensate for moisture content under job conditions. Volumetric control of the aggregates entering the structure shall be maintained, providing the concrete quantities in the structure do not exceed 50 cubic yards. The volumes will be based on the aggregate weights per cubic foot reported from the laboratory. Specified weight control will be effected on all structures containing more than 50 cubic yards of concrete.

3.39 Laboratory Control

Rigid laboratory control is exercised on all structures. No materials are to be used in the construction of a box culvert until their use is authorized by the testing department.

To aid in the testing, the engineer will sample materials as follows:

a. Mixed Aggregate
   Submit a 30 lb. sample of the pit proposed as a source for the aggregate. (Use Form No. 92).

b. Fine Aggregate
   When the aggregates are stock piled, submit a sample for check and at any later time when the material gives evidence of changing. (Use Form No. 92).

c. Coarse Aggregate
   Submit a sample from the stock pile. (Use Form No. 92).

d. Reinforcing Steel
   Ordinarily reinforcing steel is tested at the source by an authorized testing bureau. Notice will be sent the engineer from the Testing Department as to the status of the steel. If the steel is not pre-tested, submit a sample thirty inches long to the testing laboratory for inspection.

e. Cement
   All cement shall come from pre-tested bins and notice thereof shall be sent the engineer from the laboratory. On receipt of cement, the engineer shall note and record the railroad car numbers as a further check on the notice.

3.4 Stock Passes

Installations for stock passes are uncommon and when proposed for a project, the construction methods and materials test requirements are usually outlined in the "Special Provisions.'

3.41 Pipe Installations 84" pipes when designed for use as stock passes, should be located at points where good sidehill drainage can be effected. Ingress and egress shall be provided by excavating over a wide area to provide a gradual approach. In this special case the minimum cover to the roadway grade shall be one foot; the maximum fill to the bottom of the pipe then would be eight feet and the length then shall be but twenty-two feet more than the finished roadway width. Staking and recording of notes will be similar to the form prescribed in Paragraphs 3.27, 3.28. Entries will be listed on the estimates in the space provided therefor on page 2.

3.42 Timber Stock Passes Timber stock passes shall be built according to the design specified in the "Design" Specifications for Highway Structures. Control of the materials according to the Standard Specifications will be effected as outlined in Section 34, Satisfactory approaches to the stock pass will be provided as shown in Paragraph 3.41. Staking and recording of notes similar to the form outlined in Paragraphs 3.27, 3.28. Entries on the estimates will be listed on pages 2 and 3 under the headings provided.

3.43 Concrete Stock Passes Concrete box culverts, when installed in sufficient size are used at times as stock passes. The staking, recording of notes and control of the work would be similar to that outlined in Paragraph 3.3-3.39.

3.5 Miscellaneous Structures Other structures such as metallic ditch lining, flumes, syphons, drop inlets, sewers and manholes, when specified for installation, will be staked and recorded with the same precision required for other structures mentioned hereinbefore. Ordinarily these installations are covered by special designs and provisions and the practices outlined therein should be followed closely. Entries on the estimate will be made on the lower half of pages 2 and 3 of the estimate under improvised headings.

CHAPTER IV

SURFACING

4.1 Sub-Base Material Sub-base material is placed on the roadway to strengthen the subgrade foundation, however, in recent practice, the specifications have been broadened to the extent that sub-base material is now considered an essential part of the surfacing course.

4.11 Preparation of Subgrade Prior to placing sub-base material, the subgrade should be checked thoroughly and all weak spots marked for treatment. If any weaknesses have developed, they shall be excavated to a firm foundation and sub-base material placed as a reinforcing agent. Before placing the sub-base material as a course, the subgrade shall be trued to the contours indicated on the typical section. Blue tops will then be placed to indicate the finished roadway grade and to aid the contractor in shouldering.

4.12 Placing All sub-base material shall come within the grading limits set forth in the specifications. The engineer shall regulate the excavation of the material at the source so that the product delivered to the roadway will not vary in texture or density. When the material is delivered it shall be dumped in overlapping courses to further guarantee a uniform mixture. The material will be dumped to the lines indicated by the blue tops, care being taken that no waste is effected over the shoulder of the subgrade. The Specifications stipulate that should oversize be present at the source in excess of 5%, the material shall be passed through a screen or grizzly at the pit; it being the intent of the specifications that the delivery of oversized material to the roadway will be discouraged.

The final operation involves the use of a blade and the material shall be processed until it presents a well mixed appearance, true to line and grade.

4.13 Measurement Sub-base material, unless otherwise specified, is measured loose in the hauling unit at the point of delivery. The engineer shall ascertain the capacity of each hauling unit and record the measurement and yardage calculations in the "Surfacing" notebook.

4.14 Notes All records pertaining to the placing of sub-base material shall be entered in the "Surfacing" notebook. The theoretical amount of material required between stations should be checked daily against the actual amount placed. The form of the record in the notebook shall be as follows:

LEFT HAND PAGE

Sta. to Sta.	Truck No. & Capacity	Total Day	Grand Total	Plan Total

The right hand page of the notebook shall show the underrun or overrun of quantities, weather conditions, record of samples, pit locations, etc.

4.15 Estimates Basic headings are provided in the upper half of page 2 of the estimate blank.

4.16 Laboratory Control The laboratory requires one sample of each pit proposed as a source of sub-base material. The engineer is referred to Par. 4.283 for further particulars relating to field materials control.

4.2 Crushed Gravel Surfacing Material Construction details pertaining to the placing of crushed gravel surfacing material are outlined in the Standard Specifications. The material as specified comes under three headings, namely, base course, Grade A top course surfacing, and Grade B top course surfacing, and this manual will now treat with the separate classifications given in order.

4.21 Base Course

4.211 Preparation of Subgrade The condition of the subgrade prior to placing base course is of major importance. As outlined in Paragraph 4.11 the foundation will be checked for any indications of weakness. Base course should be

used sparingly, however, to correct any foundation weaknesses. The subgrade surface should be free from any wet or spongy areas and further should be crowned in an amount sufficient to drain all surface water.

4.212 Placing All work, both at the pit and at the point of delivery should be regulated so that a uniform product will be presented on the roadbed. The dumps at the point of delivery shall be in overlapping layers and any subsequent blading shall be so ordered that on completion of the base course surfacing the material will be densely uniform.

The base course will serve as a floor for later surfacing operations, hence, it is important that the material be "set up" properly. The engineer shall add binder in the amount required; if possible, the binder should be incorporated in the mix when some moisture is present so that the fine material in the binding agent will acquire cementing properties. The mixture shall then be processed until the binder is blended throughout the surfacing course.

4.22 Grade "B" Top Course

In using Grade "B" top course it is intended that the finished product will be "set up" by the cementing elements in the fine materials. It is not intended that this class of surfacing be bitumenized.

4.221 Placing The production shall be regulated at the pit so that a uniform mix will be delivered to the roadway. Special consideration is warranted in determining the satisfactory binder content.

4.23—Grade "A" Top Course

Grade "A" top course is placed for ultimate bitumenizing, hence the chief consideration is to blend the materials in a well-graded mixture that it adapted to oiling.

4.231 Placing In placing grade "A" surfacing material the engineer should see that the base course is in a well compacted condition to prevent any oversize being incorporated in the top. The material shall be dumped in overlapping layers and the blading will be regulated to the end that the surfacing is completely processed.

4.24 Binder The term binder is used for any materials added to the aggregate to serve as a cementing agent for base course surfacing and Grade "B" top course surfacing.

4.241 Placing No binder should be placed until authorized for use by the Testing Department, or as indicated by the findings of the field tests. The engineer in the field will determine the amount of binder required to "set up" the base and Grade B top course, care being taken that the mixtures when blended will come within the specified gradation limits. Paragraph 4.2835 treats more in detail with this feature of construction and the engineer is referred thereto for guidance.

When placing binder the engineer should see that the material is mixed completely throughout the aggregate.

4.25 Notes All notes and records pertaining to crushed gravel surfacing shall be kept in the "Surfacing" notebook. The work shall be segregated to show the various courses placed. The form of the notes shall be similar to that used for recording sub-base material. (Par. 4.14) Binder, and also overhaul on binder will be recorded in the "Surfacing" notebook. Notations should be made on the right hand page of the book relative to samples submitted, weather conditions and any other salient feature of the work.

4.26 Estimates Headings are provided on the estimate blank for all items covering crushed gravel surfacing material. In noting surfacing items, the total to date shall be shown at all times.

4.27 Laboratory Control A general control of all materials entering in the surfacing courses is exercised by the Testing Department at Helena. At the time the preconstruction samples submitted by the locator are tested, the laboratory will forward two copies of the analyses to the Division Engineer, one copy to be transmitted to the Project Engineer when he is assigned to the project. In the event that insufficient preconstruction samples have been submitted on the location survey, the laboratory

will so notify the Division Engineer and he will arrange for additional samples to be taken. These analyses will also be forwarded to the Division Engineer in duplicate; one copy to be transmitted to the Project Engineer when the assignment is made. When the contractor chooses a pit for use, it is anticipated that it will have been tested and approved as a part of the preconstruction sampling and reference to the laboratory number will serve to clear the pit as a source of surfacing material. In the event the pit has not been tested, a representative sample of the material in deposit will be submitted to Helena for test and approval. No surfacing material shall be allowed on the roadway until the pit has been approved for use by the Testing Department.

4.271 First Field Sample Each Course

On acceptance of the pit by the Helena laboratory and the beginning of crushing activities, a sample (Form No. 97) of the crushed material entering each surfacing course shall be submitted to Helena to represent all materials placed on the roadway and originating at the pre-tested pit. This sample should be taken at such a time as the run will generally typify all production placed in the surfacing interval and will serve as a check on the preconstruction sample. On this check sample, the Testing Laboratory will test for:

a. Moisture Equivalent
b. Lineal Shrinkage
c. Water Asphalt Preferential
d. Such other tests as are thought necessary or at that time demanded.
e. Material Grading

If the recommendations or corrections on the sample deal with those factors listed (a) through (d) the Project Engineer will submit another sample for inspection at Helena, in lieu of field test data. If the laboratory reports criticize the sample on the basis of improper grading it is anticipated that the Inspector will have ascertained that fact in the field and a letter referring to the field tests showing that the material is graded properly will suffice.

4.272 Second Field Sample Each Course

On near completion of each course, another sample will be submitted to Helena to serve as a check on the first sample of the crushed aggregate

and it too will be selected to represent the material in whole throughout the surfacing interval. Procedure in the test and recommendation therefor will be made at Helena according to the instruction given for the first field sample.

4.273 Submission All samples when taken should weigh not less than thirty pounds. The Testing Laboratory furnishes sacks on requisition for the purpose of shipping the samples and all shipments will be consigned thereto by express collect. The shipment will be identified by attaching two shipping tags, (Form No. 25, available in requisition) these to be addressed to the Testing Department. On the back of each shipping tag, the consignor will show information relative to the sample, similar to that given on the Report Form.

4.274 Report Form Report Form No. 97 wll be made in quadruplicate, the original to be sent direct to the Testing Laboratory, the duplicate to be enclosed with the sample, the triplicate to the Division Engineer and the last copy to be retained in the field.

4.28 Field Materials Control To supplement the comprehensive control exercised by the Testing Laboratory, the Inspector will maintain a field control of the grading of the surfacing material. These duties devolve upon the Head Inspector and, as such, he will be responsible for all field laboratory equipment issued him.

4.281 Field Testing Kits Field testing kits will be furnished as needed to comprise a complete set of screens, scales, drying equipment and other articles necessary for the full and complete screening and testing of mineral aggregates. Itemization of the contents of the field testing kits is as follows:

3—6 qt. milk pans, No. 306
3—2 qt. milk pans, No. 302
3—1 qt. milk pans, No. 301
1—Handy Scoop, No. 1
1—Handy Scoop, No. 6
1—Bench Brush
3—Drip Pans
1—Kerosene Stove

1—Screen Brush
1—Gold Pan, No. 42
1—5″ Trowel
1—Counting Scale, No. 601
1—10 qt. Bucket
1—2 pt. Dipper
1—1″ Square Screen
1—½″ Square Screen
1—3-mesh Square Screen
1—10-mesh Square Screen
1—40-mesh Square Screen
1—80-mesh Square Screen
1—200-mesh Square Screen
2—8″ Metal Screen Pans
1—Field Screen, 16″ diameter, ¼″ circular opening
1—Field Screen, 16″ diameter, ½″ circular opening
1—Field Screen, 16″ diameter, ¾″ circular opening
1—Field Screen, 16″ diameter, 1¼″ circular opening
1—Field Screen, 16″ diameter, 1½″ circular opening
1—36″x36″ close-woven Canvas Sheet.
37 pieces.

4.282 Responsibility As stated herebefore the Head Inspector will be responsible for the care and use of the field laboratory equipment. The sets will be carefull preserved, all parts kept in clean working condition and when not in actual use shall be replaced in the kits provided therefor. Neglect, carelessness or loss of equipment will result in immediate dismissal of the responsible person.

4.2821 Care of Test Equipment It is contemplated that the field test kits will last through several seasons work. Replacements, when necessary, will be delivered on requisition and a satisfactory explanation for the needed replacement. Some of the pieces are extremely delicate, particularly the 200-mesh sieve; the dropping of a common lead pencil on this screen could easily render it unfit for further use and would at least so expand several hundred of the 40,000 meshes in the square inch surrounding the point of impact as to make re-calibration necessary before accurate results could be obtained thereafter. Moderately soft brushes for cleaning screens have been included in these kits, but **under no circumstances** should they be used on a 200-mesh screen as the bristles or fibers are usually greater in diameter

than 0.0029" which is the maximum clear opening of a 200-mesh screen. In this same connection it is well to remember that no material should be screened to the 200-mesh sieve that is larger than that material passing the 40-mesh screen.

The stoves are designed and sold for use with kerosene only and any operator using other combustibles does so at his own risk.

The scales are the most expensive piece of equipment in the kit and will weigh to 0.01 pounds, if kept clean and in adjustment. Each piece of equipment is securely anchored in its respective compartment, and no field kit should be transported until all equipment is packed in its proper place.

4.283 The Field Test

The Inspector shall make field screen analyses to represent the material in place in each course for each 1,000 foot interval and as many additional times as needed to control the gradation of the material. The sample will be taken at the plant as the material drops from the conveyor belt into the loading bin; in so taking the sample, care should be taken to run the sample container completely through the material. The sample would then be built up in small quantities until it totals at least thirty pounds by weight.

The instructions following, for the sake of exemplification will refer in the main to Grade "A" surfacing, however the methods outlined will be applicable in the field control of all untreated surfacing. It is the intention in maintaining a field control of surfacing operations that the various grades and types of surfacing will conform to the limits prescribed in the gradation tables given in the Standard Specifications. As an example, the field control of Grade "B" surfacing would be based on the materials passing and being retained on the ¼-inch and ¾-inch screens and the notes and conclusions thereof would be based only on those limits. The control of Grade "A" surfacing would involve the measurement of materials passing and being retained on all sieves ranging from the ¾" screen through the ¼", the 10-mesh, the 40-mesh and the 200-mesh; the notes and conclusions thereof would be based on the limits prescribed in the Specifications for that particular type of surfacing.

4.2831 Aggregate Charts Aggregate charts, Form No. 104, have been provided upon which each screen analysis will be noted, both by graph and itemization, particular care being taken that the analysis is definitely located with reference to the surfacing interval. These charts will be made up in quadruplicate, two going at the conclusion of each month's surfacing to the Testing Laboratory, one to the Division Office and one being retained in the field files. Results of screen analyses will be referred by number in the "Remarks" column of the surfacing notebook. The requisite computations and field procedure in making the test and recording same will be discussed under the next topic.

4.2832 Procedure The Standard Specifications identify or distinguish surfacing aggregates in their courses by prescribing limits of materials passing and being retained on standard circular screen openings or in the finer gradation, on specified mesh openings. According to assignment, then, the inspector would control the maximum sized aggregate as follows:

Subbase Gravel—3½" circular opening.
Base Course—1¼" circular opening.
Top Course, Grades "A" and "B'—¾" circular opening.

Other maximum sized material if used will be controlled by the limits prescribed in the Special Provisions and these limits in the specific case and all others will govern when making the field test.

The following procedure is outlined as the approved method to determine the percentage weights of component materials, passing and being retained on the various limiting screens and sieves specified for each type of surfacing. All materials will be screened dry through the various specified openings from the maximum to the 200-mesh sieve.

(1)—Materials Passing the Maximum Specified Opening.

Carefully select a 25-pound sample representative of the material in the 1000-foot interval, screen through the specified maximum circular screen, weigh the aggregates passing and retained and reduce each separate weight to a percentage factor. In most cases all materials will pass the maximum opening, otherwise corrective measures should be taken at the plant. If oversize is present in very small quantity, record as a "trace" and continue

the test with the full 25 pounds, this to be considered as the basic 100% of the sample by weight.

The first record of the test then would be that all materials passed the maximum specified screen opening; in the case of Grade "A" surfacing the notation would read "-¾-inch screen (circular) 25 lbs. 100%."

(2)—Material Passing the ¼-inch Screen.

Having ascertained that the material represented by the sample was acceptable on the basis of comparison afforded by screening through the maximum specified opening, the sample would be tested on the basis of the next lower gradation specified; in the case of Grade "A" surfacing this would be the ¼-inch circular screen. The procedure then would be to test the whole sample on the ¼-inch screen, weigh the materials passing and retained and reduce to percentage factors. For purposes of exemplification, it is assumed that 13 pounds of the material passing the maximum screen opening in the first test operation, passed the ¼-inch screen and by checking the weight, 12 pounds were retained on the screen. The weight percentages then would be 52% and 48% respectively. The notation to record the test then would be:

		+	—
(1)—¾-inch screen (circular)	25 lbs.		100%
(2) +¼-inch screen (circular)	12 lbs.	48%	
—¼-inch screen (circular)	13 lbs.		52%

(3)—Material Passing the 10-Mesh Sieve.

From the material passing the ¼-inch screen, select a sample to represent all that material graded below the ¼-inch circular opening. This can be effected by quartering the sample on the canvas sheet provided in the testing kit. To quarter a sample, the tester would place all the -¼-inch material on the sheet, re-mix to restore a uniform distribution of the fines and then divide in four parts, this division to be made in vertical planes by the use of scoops or such other equipment as will suffice. Having divided the material in four parts, the "quartering" would be extended until such time that a sample slightly in excess of one pound remains for further analysis. This sample would then be heated to a temperature not exceeding 110°C (230°F.) to dry the aggregate and to establish a constant weight. The sample being prepared accordingly, exactly one pound would be taken therefrom and screened dry on the 10-mesh sieve. It is to be emphasized that the grading

limits on the finer mesh opening are more confining than those mentioned herebefore and special effort should be made to prepare a truly representative sample.

The tests of the material passing the ¼" circular screen are based on the analysis of the one pound sample, however the findings are amplified to represent the grading of the original 25 pound sample and certain computations are involved to establish these relative conclusions. Knowing the percentage of ¼" material present in the original sample, (operation No. 2) the tester would base all subsequent conclusions on that percentage. The weights then of the materials passing and being retained on the sieves smaller than the ¼-inch circular screen would be expressed in hundreths parts of the one pound sample and this grading within the sample would be modified by the percentage passing the ¼-inch screen to express it as a weight percentage of the original 25 pound sample.

Continuing the example of field test procedure, if on screening through the 10-mesh sieve it were found that 0.81 pounds passed and 0.19 pounds were retained the results would be so expressed and modified by the percentage of the whole sample passing the ¼-inch screen. The field notation to this point would then be:

			+	—
(1)	—¾ screen	25 lbs.		100%
(2)	+¼ screen	12 lbs.	48%	
	—¼ screen	13 lbs.		52%
(3)	+10-mesh (.19)	.52	9.88%	
	—10-mesh (.81)	.52		42.12%

(4)—Material Passing the 40-Mesh Sieve.

The material passing the 10-mesh (in the example 0.81 pounds) would then be screened through the 40-mesh sieve and the weight of the material passing would be reduced to a percentage factor and recorded. If, for example, 0.50 pounds passed the 40-mesh screen and 0.31 pounds were retained, the record of the test to that point would be as follows:

			+	—
(1)	—¾" screen	25 lbs.		100%
(2)	+¼" screen	12 lbs.	48%	
	—¼" screen	13 lbs.		52%
(3)	+10-mesh	(.19) .52	9.88%	
	—10-mesh	(.81) .52		42.12%
(4)	+40-mesh	(.31) .52	16.12%	
	—40-mesh	(.50) .52		26.00%

(5)—Material Passing the 200-Mesh Sieve.

Up until the last stage of the field test, the materials will have been dry screened through the various screens and sieves. The next step involves the use of water to facilitate the separation of the —200-mesh particles from the coarser material. Place that material passing the 40-mesh sieve on the 200-mesh sieve and introduce water in an amount sufficient to wash the fine particles through the mesh openings. During the time the sample is being washed the operator will agitate the contents of the screen to expedite the test, however, care should be taken that none of the coarser material, if held in suspension is decanted over the side of the screen bracket. When the wash water is clear as it drains through the openings, the field screening will be complete. All that material retained on the screen will then be dried to a constant weight at a temperature not exceeding 110°C (230°F.) and weighed to the nearest hundreth of a pound. The difference between the original weight of the —40 mesh material and the dry weight after washing represents the amount passing the 200-mesh sieve.

Adverting to the example described herebefore, if it were found that 0.18 pounds of the material passing the 40-mesh screen were washed through the 200-mesh sieve, the final screen analysis would be presented as follows:

(1)	—¾″ screen	25 lb.			100%
(2)	+¼″ screen	12 lb.		48%	
	—¼″ screen	13 lb.			52%
(3)	+10-mesh	(.19 lb.)	.52	9.88%	
	—10-mesh	(.81 lb.)	.52		42.12%
(4)	+40-mesh	(.31 lb.)	.52	16.12%	
	—40-mesh	(.50 lb.)	.52		26.00%
(5)	+200-mesh	(.32 lb.)	.52	16.64%	
	—200-mesh	(.18 lb.)	.52		9.36%

4.2833 Record of the Test Having completed the field test and incidental computations, the Aggregate Chart would then be prepared for entries thereon. The headings can be filled out from the field records and files. Particular attention is called to the sample analyses at the bottom of the form, these being the absolute record of the tests. Sample numbers will be assigned as the samples are taken in sequence for each course. To clarify all

details the manual will now extend the typical field test exemplified in the preceding paragraphs. Assuming the typical sample were the fifteenth taken in the top course surfacing, the sample would be recorded as number 15. The Station to Station interval represented by the sample would be procured from the gravel checker at the dump, and in turn to complete the quantity records, the tester would give the checker the sample number typical of the run. The data entered on the Aggregate Chart to cover the typical field sample then would be as follows:

1st Graph This Chart.....

Sample No. 15, Sta.....to Sta.....

Passing	Retained On	Retained Pounds	Retained %	Total % Passing
3/4"	.....	25 lbs.	....	100 00
3/4"	1/4"	12 lbs.	48	00	100 00
1/4"	10 m	.19	9	88	52 00
10 m	40 m	.31	16	12	42 12
40 m	200 m	.32	16	64	26 00
200 m	.....	.18	---	---	9 36
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....

Operation (1)
" (1) and (2)
" (2) and (3)
" (3) and (4)
" (4) and (5)
" (5)

As a check on the work it is to be noted that the materials retained by percentage plus the material passing the 200-mesh sieve will always total 100%; also, the materials graded below the ¼-inch screen and rated by weight will always add to 1 pound.

The analysis is merely the act of copying the field test computations in their "Passing" (–) and their "Ret. on" (+) categories. A check with the Standard Specifications would show that the material represented by the field test sample conformed to the limits prescribed in the gradation table for Grade "A" Surfacing.

In addition to the notations of the analysis, it is necessary that the Inspector illustrate the grading of the material in graphical form in the space provided. Legends are provided for each test in sequence on the Chart. As shown on the form the vertical spacing is divided to give the "Percent Passing" and the horizontal spacing gives the Screen Opening and the "Screen Number" on the top and the bottom of the sheet, respectively. The operations in plotting the graph would be as follows:

a. Prepare the chart to show the vertical limits of each gradation; in the case of Grade "A" surfacing, these limits on the 40-mesh screen would be shown by a line drawn from 15% to 35%. These lines would be drawn to the right of the vertical line indicating the screen or mesh control, but close enough to serve as a comparison.

b. The actual field findings would then be plotted from the "Total % Passing" column in the analysis and the lines connected to show the test curve.

Succeeding tests would be plotted and their analyses noted to typify the material on the roadway for that day's run. Space has been provided to enter the record of three field tests, it being anticipated that this number of tests will suffice for most daily runs. If, however, more tests are required to control the work, another Chart will be made up in the manner stipulated above, the first sample record on the second sheet being plotted with a solid line, the second with a broken line, etc.

The graph record of the analyses will serve as a convenient basis to control the "Allowable Variations within Run." See Standard Specifications, page 29.

4.2834 Applying the Findings It is obvious that the field materials control is exercised to guarantee an acceptably graded product being placed on the roads. To apply the findings of the field test the following directions would hold:

a. Sub-Base Material.

The control of the gradation of Gravel Sub-Base material is based on the limits prescribed for the material passing and being retained on the 3½" screen and the ¼ screen. If, from the field test, it was found that the sub-base was lacking in –¼ inch material, the production at the source would be regulated until such a time as it passed the requirements in the gradation table. For this particular type of surfacing it is a rarity that binder is needed and if proper control is exercised, no binding material need be added.

b. Grade "B" Top Course and Base Course.

Grade "B" Top Course and all base courses are graded on the maximum specified openings and the material passing and being retained on the ¼-inch screen. If, then, the material does not conform to the specified gradation, suitable steps will be taken to correct the departure in grading at the source. The corrective measures will be advanced until the crushed material as delivered to the roadway answers the demands of the Specifications as to grading.

4.2835 Cementing Agent As stated before it is intended that Grade "B" top course and base course will be "set up" by the cementing elements in the fines; the field test would not serve as a check of the cementing elements other than to indicate the presence of fines minus the ¼-inch screen. The determination of required binder content would depend on the reaction of the roadway surface to traffic and weather conditions. The laboratory report forms would also govern in determining the required binder content inasmuch as they would show the clay content of the surfacing material and also the clay content of any binder pits proposed for use. The required binder would then be estimated and placed to "set up" the surfacing course and still come within the limitation of the Specification stating that the "percentage of clay in the entire surfacing material shall not exceed 15%.

Binder samples must be submitted and tested before any of the materials thus proposed are used.

c. Grade "A" Surfacing.

It is intended in exercising the field control of the gradation of material on Grade "A" surfacing that all aggregates as delivered to the roadway will conform to the grading demands of the Specifications. In thus conforming to the Specifications, there will be no need for incorporating "filler" in the surfacing course as a separate item of the contract. If fines are required, they shall be entered in the mixture at the plant and thus paid for as a part of the crushed material. If the material does not conform to the Specifications as to grading, corrective measures shall be taken at the plant and continued until such a time that the field tests show the material acceptable on the basis of gradation.

4.29 Traffic Protection

Special attention should be given to the protection of traffic, both during the act of surfacing and immediately after completion. The following suggestions are advanced for compliance:

a. If laid under traffic level all dumps immediately.

b. If work is being advanced at night, see that sufficient warning lights and signs are placed at all points of danger. The material, in the case of night work, shall be dumped along the side of the road, outside the traffic lane on the contractor's responsibility.

c. Ordinarily a surfacing course will not set up until completely processed. Signify these intervals while they exist by "LOOSE GRAVEL" signs and warning lights.

d. Do not allow the gravel trucks to drive at a rate of speed which would endanger the public.

4.30 Finishing

The engineer should inspect the project during the course of surfacing work and mark all ravels, loose materials, weakened shoulders, etc., for correction. On the final cleanup the shoulders should be aligned, approach roads trued to symmetrical lines, and if the gravel pit is within easy sight distance it should be sloped and any waste piles of rock should be disposed along the floor of the pit.

4.3 Road Mix Oiling

The Standard Specifications outline the procedure in road mix oiling. Incidental engineering work is outlined as follows:

4.31 Equipment The size and condition of the contractor's equipment should be checked to see that it conforms to the demands in the specification.

4.32 Sections As a means to control the work, the project should be divided in sections one mile long. These intervals would then serve as the basis for the distribution of oil, the processing, the sealing and such other items as are reported on the Weekly Oil Reports.

4.33 Construction Supervision

4.331 Scarification All scarification should be regulated so that the base course will not be disturbed.

4.332 Stack The material when stacked in the windrow prior to oiling should be measured in cross-section to ascertain the probable volume on completion. The typical section and end area thereon would govern, however the end area of the stack should be about twenty per cent in excess of the area shown as a compacted mat.

4.333 Oil Content Screen tests of the material in the stacks and the volume thereof will govern in determining the oil content. The maximum oil content should in no case exceed 4%. The table following will guide in setting the oil content, however, the engineer in the field should inspect the work constantly and build up to a satisfactory oil content during the course of the work.

OIL REQUIRED IN GALLONS PER SQ. YD.

Per Cent Aggregate	Thickness of Compacted Mat			
Passing ¼" Screen	1 In.	2 In.	2½ In.	3 In.
40.0	.478	.958	1.187	1.437
42.5	.489	.980	1.216	1.470
45.0	.500	1.003	1.245	1.504
47.5	.512	1.025	1.274	1.537
50.0	.523	1.048	1.303	1.571
52.5	.534	1.070	1.332	1.604
55.0	.546	1.092	1.361	1.638
57.5	.557	1.115	1.390	1.671
60.0	.568	1.137	1.419	1.705
62.5	.580	1.160	1.448	1.738
65.0	.591	1.182	1.477	1.772

4.334 Application Bituminous material should be applied uniformly to avoid "fat" or "lean" spots. Provision should be made to accommodate traffic by oiling the materials in widths, designed to leave an unobstructed traffic lane.

4.335 Mixing In mixing, the engineer should adhere to the practice outlined in the specifications. Care should be taken to keep the material within the limits of the finished surfacing area so that the base will not be stained beyond the edges of the finished mat.

Mixing should be continued until all particles have been completely coated. The mix should be uniform in color and free from streaks. Physical indications of an ideal mix are cited below as a guide:

a. The mix should creep when disturbed.

b. A handful squeezed in the palm of the hand will compact into a ball and retain that shape when the hand is opened.

c. When rubbed on the palm of the hand under pressure the mix will leave a brownish stain.

d. When a blade cuts into and removes part of the stack the face left will tend to hold its vertical shape without immediately slumping.

e. The mix will be dully stained rather than glistening.

4.336 Spreading On completion of the mixing, the material shall be spread to the lines indicated on the typical section. Care should be taken that the edges of the mat present symmetrical lines with respect to the shoulders. If some difficulty is experienced in spreading to the required lines, the finished surfacing lines should be staked. Care should be taken that the crown is preserved in the laydown. All areas which would have a tendency to retard quick surface water runoff should be corrected. The crown should be accentuated on "dips" in the roadway where the longitudinal grade approaches being level.

The surface on all curves should be brought to a straight transverse grade in cross-section; this can be effected by blading from the inside of the curve to the outside, care being taken, however, that an adequate mat depth is left on the inside of the curve. All blading units on the laydown shall be equipped with twelve foot moldboards.

4.337 Moisture The presence of excess moisture in any mix is fatal. The limit of moisture specified is two percent and the engineer shall consider the specification of utmost importance.

If, when operating, rain commences to fall, the treated material should be promptly windrowed; if it is apparent that the shutdown is to be of considerable time, provision should be made to drain the exposed subgrade. On resumption of the mixing, the subgrade should be dry and the treated aggregates dry enough to comply with the specifications.

4.34 Correlated Construction Items

4.341 Sealing Sealing is now effected by applying rapid curing naphtha cutback asphalts. Care should be given to cleaning the surface prior to applying the sealing agent. Satisfactory results have been attained by applying the seal coat at the rate of one-tenth gallon per square yard of road surface. Other controls are as follows:

a. Apply the seal coat at a maximum temperature of 90°F.

b. Apply to one-third the roadway surface at a time. Flagmen should be provided to direct traffic away from the spread until such a time that the seal coat has hardened.

c. If feasible, regulate the delivery of the oil to the roadway, to arrive there at such a time as the mat will have been heated by mid-day temperatures.

4.342 Tack Coat A tack coat is specified for use, generally on roadway surfaces which do not compact readily. The tack coat should be applied only to a well bound surface, free from dust and loose material. As in sealing, adequate provision should be made for the convenience of the traveling public.

4.343 Temperatures The Specifications cite the temperatures at which the oil of the various grades and classifications should be applied, and the Inspector should regulate this feature of the work by checking the temperatures of the oil as delivered to the roadway in distributor lots. Armored thermometers will be supplied by the Testing Laboratory on requisition.

4.344 Rolling The specifications outline the approved procedure in rolling. However, the method should be modified to allow rolling on super elevated curves from the inside across the roadway to the outside.

Rolling should be minimized to avoid crushing the aggregate and thus present unoiled surfaces in the mix. The work will be considered finished when the mix ceases to show any movement under the wheels.

Rollers are to be used whenever specified; under no circumstances should their use be waived on small projects either in urban areas or in suburban areas.

4.35 Reports Several reports are required from the field for the convenience of the Headquarters Office. Methods and form are given herewith:

a. Weekly Oil Report. (Form No. 21). This report will be made in triplicate, the original and duplicate being sent to the Division Office. The period covered will always end on Saturday.

In numbering the miles on the project, the beginning of the project as shown on the plans will govern in starting the mile count. Arrows, indicating the direction and extent of the work will be drawn as needed for the different items in the contract.

In the column which shows "Shipper of Mat Oil" and "Shipper of Seal Oil," show both the grade of oil and the company that is supplying it. In the "Grade Prepared" column, indicate by directional arrows the extent and direction of all work in preparing the grade. If several intervals are being prepared, each unit will be clearly indicated by directional arrows. Other columns "Mat in Place", "Rolling", and "Seal Coat" will be filled in and the direction and extent of the work will be shown by arrows. Where it is found necessary to use an additional column for "Tack Coat" or such, the item would be entered immediately below the "Seal Coat" column and the extent and direction noted on all subsequent reports.

Show the total gallons of each kind of oil received to and including the date of the report.

Carload shipments of oil will be shown twice, once when the car is received and once when released. Any car received and distributed to two or more projects shall be shown in the "Otherwise and Explain" column, the amount and distribution being noted therein.

To arrive at the "Oil on Hand" on each report, figure the balance as follows:

Report No. 1: Add all shipments received and deduct the quantity shown on the road.

Report No. 2: Add the gallonage received during the week to the "Oil on Hand" for Report No. 1 and deduct the amount used during the week for the "Oil on Hand." Subsequent reports would be noted similarly. If any other deductions are made, this should be shown in the "Otherwise and Explain Column."

All carloads of oil, tank or truck, when shown released on the report should be distributed according to their use along the project.

Any other pertinent facts should be noted in the "Explanation of Delays" column and the "Remarks" column.

b. Invoices.

The refiner will present the chemist at the Branch Laboratory with three copies of his invoice to the contractor. The chemist, on checking the invoices with the gallonage shown on the acceptance slip, will okay them and transmit them to the field engineer. The field engineer will then show the distribution for each car on the invoice and transcribe the information as described herebefore to the Weekly Oil Reports. Two copies of the invoice will then be sent the Division Office.

c. Shipping Notices.

When oil is shipped in tank car lots, the field engineer should wire or call the refiners at the time the first order is placed, requesting them to mail him a shipping notice showing the gallonage and loading temperature for that shipment and all those thereafter.

d. Daily Weather Reports, Form No. 62.

Extension of Time for Unloading Cars, Form No. 63,

Freight Tariff B. T. Jones, No. 4-N as of September, 1933, Section No. 1, Item No. 245, Rule 8, Section A, Paragraph 2, which reads as follows: "When, at time of actual placement, lading is frozen or congealed so as to require heating, thawing or loosening to unload, the free time allowed shall be extended forty-eight (48) hours, making a total of ninety-six (96) hours free time, provided the consignee shall, within forty-eight (48) hours after actual placement, serve upon this railroad's agent a written statement that the lading was in such frozen or congealed condition at the time of actual placement."

In order to take advantage of the ruling regarding weather conditions, when oil is delivered to the State for use by the State, it will be necessary that field engineers notify the railroad agent in charge of the unloading point, in writing, each day of the weather conditions, and claim time for each day that the weather conditions prevent the unloading of oil. These notifications of weather conditions must be made in duplicate on Form No. 62 and the duplicate copy will be retained by the field engineer, and must be attached to the demurrage claim when it is submitted to Helena for payment.

In order to fully comply with the rules relative to congealed material, the men in charge in the field shall notify the railroad agent and receive his acceptance of the notice within 48 hours after the car is placed.

Claims for Extensions of Time will be made on Form No. 63 and must be served upon the railroad's agent within 48 hours after actual placement of the shipment. The claim shall be made in duplicate and the duplicate copy will be retained by the field engineer and must also be attached to the demurrage claim when it is presented.

To avoid demurrage charges cars should be released prior to 7:00 A. M. However, should the railroad's office not be opened for the transaction of business until a later hour, this later hour shall be considered the hour of release and cars released at that time in this particular instance will not be subject to demurrage charges for the time intervening.

No demurrage charges will be allowed for Sundays, legal or State holidays.

A complete record, (to establis the basis for the preparation of Forms No. 62 and 63) on each carload of oil or asphalt used by the Highway Commission must be kept in the field, and the information contained should be similar to the following example:

Car QTX 1408—Placed 9/14/34—Heating (Free Time)
9/15/34—Heating (Free Time)
9/16/34—Snow
9/17/34—Rain
9/18/34—Clear (Free Time)
9/19/34—Sunday (Free Time)
9/20/34—Rain
9/21/34—Clear (Free Time)
Released 9/22/34—Clear, 1 day demurrage @ $2.00

It so happens that cars are occasionally "bunched" at the point of delivery, in that event the following is presented as a guide in rendering a claim to void demurrage charges:

"Cars for unloading or reconsigning. When, as the result of the act or neglect of any carrier, cars originating at the same point, moving via the same route and consigned to one consignee at one point, are bunched or when cars originating at different points and transported via the same route from an intermediate common point to destination are bunched after arriving at the common point (in which event the dates of arrival of the cars at common point will govern in determining the bunching instead of the dates of shipment) and are tendered for delivery by this railroad in accumulated number in excess of daily shipment, the consignee shall be allowed such free time as he would have been entitled to had the cars not been bunched, but when any cars are released before the expiration of such free time, the free time on the next car will be computed from the first 7:00 A. M. following such release; provided, however no allowance will be made unless claim is presented in writing to the railroad agent within thirty (30) days, exclusive of Sundays and legal holidays, after the date on which bill for demurrage is rendered, supported by the receipted bill as evidence of payment of the demurrage as originally charged and a statement showing date and point of shipment of each car involved in the bunching claim. Also under this rule cars moving from different points or via different routes to destination and arriving on different dates will be considered bunched if tendered for delivery on one day, and such free time shall be allowed as the consignee would have been entitled to, had the cars been placed or tendered for delivery in the order of their arrival."

4.36 Notes

The weekly oil reports constitute a complete record of the project; however, certain notes in more or less of a diary form should be kept to substantiate the information in the weekly report. This data would consist of the gallonage used daily, the station to station intervals, the oil received, temperatures, etc. The notes would be recorded in the "Surfacing" notebook. A complete diary should be kept to record all salient features, particularly the weather conditions and hours worked.

4.37 Laboratory Control

Great responsibility for complete and satisfactory laboratory control devolves upon the Field Engineer. The procedure and sequence outlined below are set forth for strict compliance:

a. Road Oil

Branch laboratories have been established at refineries which generally supply road oil. At these points the field chemist will make a conditional acceptance of each individual shipment and send the notice (Form No. 103) the original white copy going to the Field Inspector, either by mail or by truck driver. In no case shall road oil be used which has not been certified acceptable by the field chemist. The field test and acceptance is subject to change by the Helena laboratory in that their tests are more exacting. In this latter event, should the Helena tests show unsatisfactory results, the Commission reserves the right to discontinue further acceptance from such sources. To expedite all communications between the Branch Laboratory and the field the Division Engineer should notify the two parties concerned as to their respective postoffice addresses and telephone numbers.

On receipt of the oil and the acceptance thereof the engineer should take a temperature reading on each load as it is received in order to secure conformity with the specifications as to the temperature at which the oil is to be applied, and also to check the gallonage of the load as it is delivered against the gallonage as loaded or as shown on the acceptance slip. This would apply basically to all truck consignments.

On tank cars, the dome capacity of each car should be measured, i. e., the distance taken from the bottom of the dome to the level of the oil or if the oil should be below the bottom of the dome, measure the distance from the level of the oil in the car to the bottom of the dome. Temperatures will be recorded as for individual truck consignments.

The temperatures taken as directed above will be recorded in the notes. Temperature corrections are as follows:

Group O (up to 14.9° API)

SC-2	MC-2	RC-2	80+
SC-3	MC-3	RC-3	85+
SC-4	MC-4	RC-4	90+
	MC-5		95+

(t=temperatures in degrees F; M=multipliers)

t	M	t	M	t	M	t	M	t	M
0	1.0205	50	1.0034	100	.09864	150	0.9695	200	0.9527
1	1.0202	51	1.0031	101	.9860	151	.9691	201	.9523
2	1.0198	52	1.0027	102	.9857	152	.9688	202	.9520
3	1.0195	53	1.0024	103	.9854	153	.9684	203	.9516
4	1.0191	54	1.0020	104	.9850	154	.9681	204	.9513
5	1.0188	55	1.0017	105	.9847	155	.9678	205	.9510
6	1.0185	56	1.0014	106	.9844	156	.9674	206	.9506
7	1.0181	57	1.0010	107	.9840	157	.9671	207	.9503
8	1.0178	58	1.0007	108	.9837	158	.9668	208	.9500
9	1.0174	59	1.0003	109	.9833	159	.9664	209	.9496
10	1.0171	60	1.0000	110	.9830	160	.9661	210	.9493
11	1.0167	61	.9997	111	.9827	161	.9658	211	.9490
12	1.0164	62	.9993	112	.9823	162	.9654	212	.9486
13	1.0161	63	.9990	113	.9820	163	.9651	213	.9483
14	1.0157	64	.9986	114	.9816	164	.9647	214	.9480
15	1.0154	65	.9983	115	.9813	165	.9644	215	.9476
16	1.0150	66	.9980	116	.9810	116	.9641	216	.9473
17	1.0147	67	.9976	117	.9806	167	.9637	217	.9470
18	1.0143	68	.9973	118	.9803	168	.9634	218	.9466
19	1.0140	69	.9969	119	.9799	169	.9631	219	.9463
20	1.0137	70	.9966	120	.9796	170	.9627	220	.9460
21	1.0133	71	.9963	121	.9793	171	.9624	221	.9456
22	1.0130	72	.9959	122	.9789	172	.9620	222	.9453
23	1.0126	73	.9956	123	.9786	173	.9617	223	.9450
24	1.0123	74	.9952	124	.9783	174	.9614	224	.9446
25	1.0120	75	.9949	125	.9779	175	.9610	225	.9443
26	1.0116	76	.9945	126	.9776	176	.9607	226	.9440
27	1.0113	77	.9942	127	.9772	177	.9604	227	.9436
28	1.0109	78	.9939	128	.9769	178	.9600	228	.9433
29	1.0106	79	.9935	129	.9766	179	.9597	229	.9430
30	1.0102	80	.9932	130	.9762	180	.9594	230	.9426
31	1.0099	81	.9928	131	.9759	181	.9590	231	.9423
32	1.0095	82	.9925	132	.9755	182	.9587	232	.9420
33	1.0092	83	.9922	133	.9752	183	.9584	233	.9416
34	1.0089	84	.9918	134	.9749	184	.9580	234	.9413
35	1.0085	85	.9915	135	.9745	185	.9577	235	.9410
36	1.0082	86	.9912	136	.9742	186	.9573	236	.9406
37	1.0079	87	.9908	137	.9739	187	.9570	237	.9403
38	1.0075	88	.9905	138	.9735	188	.9567	238	.9400
39	1.0072	89	.9901	139	.9732	189	.9563	239	.9369
40	1.0068	90	.9898	140	.9728	190	.9560	240	.9393
41	1.0065	91	.9894	141	.9725	191	.9557	241	.9390
42	1.0061	92	.9891	142	.9722	192	.9553	242	.9386
43	1.0058	93	.9888	143	.9718	193	.9550	243	.9383
44	1.0054	94	.9884	144	.9715	194	.9547	244	.9380
45	1.0051	95	.9881	145	.9711	195	.9543	245	.9376
46	1.0048	96	.9878	146	.9708	196	.9540	246	.9373
47	1.0044	97	.9874	147	.9705	197	.9537	247	.9370
48	1.0041	98	.9871	148	.9701	198	.9533	248	.9367
49	1.0038	99	.9867	149	.9698	199	.9530	249	.9363

Group O (up to 14.9° API) (Cont'd.

SC-2 MC-2 RC-2 80+
SC 3 MC-3 RC-3 85+
SC-4 MC-4 RC-4 90+

(t=temperatures in degrees F; M=multipliers)

t	M	t	M	t	M	t	M	t	M
250	0.9360	300	0.9195	350	0.9031	400	0.8869	450	0.8709
251	.9356	301	.9191	351	.9028	401	.8866	451	.8706
252	.9353	302	.9188	352	.9025	402	.8863	452	.8703
253	.9350	303	.9185	353	.9021	403	.8860	453	.8700
254	.9347	304	.9181	354	.9018	404	.8856	454	.8697
255	.9343	305	.9178	355	.9015	405	.8853	455	.8693
256	.9340	306	.9175	356	.9012	406	.8850	456	.8690
257	.9337	307	.9172	357	.9008	407	.8847	457	.8687
258	.9333	308	.9168	358	.9005	408	.8843	458	.8684
259	.9330	309	.9165	359	.9002	409	.8840	459	.8681
260	.9327	310	.9162	360	.8999	410	.8837	460	.8678
261	.9323	311	.9158	361	.8995	411	.8834	461	.8674
262	.9320	312	.9155	362	.8992	412	.8831	462	.8671
263	.9317	313	.9152	363	.8989	413	.8827	463	.8668
264	.9313	314	.9149	364	.8986	414	.8824	464	.8665
265	.9310	315	.9145	365	.8982	415	.8821	465	.8662
266	.9307	316	.9142	366	.8979	416	.8818	466	.8659
267	.9303	317	.9139	367	.8976	417	.8815	467	.8655
268	.9300	318	.9135	368	.8973	418	.8811	468	.8652
269	.9297	319	.9132	369	.8969	419	.8808	469	.8649
270	.9294	320	.9129	370	.8966	420	.8805	470	.8646
271	.9290	321	.9126	371	.8963	421	.8802	471	.8643
272	.9287	322	.9122	372	.8960	422	.8799	472	.8640
273	.9824	323	.9119	373	.8956	423	.8795	473	.8636
274	.9280	324	.9116	374	.8953	424	.8792	474	.8633
275	.9277	325	.9113	375	.8950	425	.8789	475	.8630
276	.9274	326	.9109	376	.8947	426	.8786	476	.8627
277	.9270	327	.9106	377	.8943	427	.8783	477	.8624
278	.9267	328	.9103	378	.8940	428	.8779	478	.8621
279	.9264	329	.9099	379	.8937	429	.8776	479	.8617
280	.9260	330	.9096	380	.8934	430	.7873	480	.8614
281	.9257	331	.9093	381	.8930	431	.8770	481	.8611
282	.9254	332	.9090	382	.8927	432	.8767	482	.8608
283	.9251	333	.9086	383	.8924	433	.8763	483	.8605
284	.9247	334	.9083	384	.8921	434	.8760	484	.8602
285	.9244	335	.9080	385	.8918	435	.8757	485	.8599
286	.9241	336	.9077	386	.8914	436	.8754	486	.8595
287	.9237	337	.9073	387	.8911	437	.8751	487	.8592
288	.9234	338	.9070	388	.8908	438	.8747	488	.8589
289	.9231	339	.9067	389	.8905	439	.8744	489	.8586
290	.9228	340	.9064	390	.8901	440	.8741	490	.8583
291	.9224	341	.9060	391	.8898	441	.8738	491	.8580
292	.9221	342	.9057	392	.8895	442	.8735	492	.8577
293	.9218	343	.9054	393	.8892	443	.8732	493	.8573
294	.9214	344	.9051	394	.8888	444	.8228	494	.8570
295	.9211	345	.9047	395	.8885	445	.8725	495	.8567
296	.9208	346	.9044	396	.8882	446	.8722	496	.8564
297	.9204	347	.9041	397	.8879	447	.8719	497	.8561
298	.9201	348	.9038	398	.8876	448	.8716	498	.8558
299	.9198	349	.9034	399	.8872	449	.8712	499	.8555

Group 1 (15.0 to 34.9° API)

SC-1 MC-1
SC-1A MC-1A

(t=temperatures in degrees F; M=multipliers)

t	M	t	M	t	M	t	M	t	M
0	1.0242	50	1.0040	100	0.9841	150	0.9647	200	0.9457
1	1.0238	51	1.0036	101	.9837	151	.9643	201	.9453
2	1.0234	52	1.0032	102	.9833	152	.9639	202	.9449
3	1.0230	53	1.0028	103	.9830	153	.9636	203	.9446
4	1.0226	54	1.0024	104	.9826	154	.9632	204	.9442
5	1.0222	55	1.0020	105	.9822	155	.9628	205	.9438
6	1.0218	56	1.0016	106	.9818	156	.9624	206	.9434
7	1.0214	57	1.0012	107	.9814	157	.9620	207	.9430
8	1.0210	58	1.0008	108	.9811	158	.9616	208	.9427
9	1.0206	59	1.0004	109	.9807	159	.9612	209	.9423
10	1.0202	60	1.0000	110	.9803	160	.9608	210	.9419
11	1.0198	61	0.9996	111	.9799	161	.9604	211	.9415
12	1.0194	62	.9992	112	.9795	162	.9601	212	.9412
13	1.0189	63	.9988	113	.9791	163	.9597	213	.9408
14	1.0185	64	.9984	114	.9787	164	.9594	214	.9405
15	1.0181	65	.9980	115	.9783	165	.9590	215	.9401
16	1.0177	66	.9976	116	.9778	166	.9586	216	.9397
17	1.0173	67	.9972	117	.9775	167	.9582	217	.9393
18	1.0169	68	.9968	118	.9771	168	.9578	218	.9390
19	1.0165	69	.9964	119	.9767	169	.9574	219	.9386
20	1.0161	70	.9960	120	.9763	170	.9570	220	.9382
21	1.0157	71	.9956	121	.9759	171	.9566	221	.9378
22	1.0153	72	.9952	122	.9755	172	.9562	222	.9374
23	1.0148	73	.9948	123	.9752	173	.9559	223	.9371
24	1.0144	74	.9944	124	.9748	174	.9555	224	.9367
25	1.0140	75	.9940	125	.9744	175	.9551	225	.9363
26	1.0136	76	.9936	126	.9740	176	.9547	226	.9359
27	1.0132	77	.9932	127	.9736	177	.9543	227	.9356
28	1.0128	78	.9929	128	.9732	178	.9540	228	.9352
29	1.0124	79	.9925	129	.9728	179	.9536	229	.9349
30	1.0120	80	.9921	130	.9724	180	.9532	230	.9345
31	1.0116	81	.9917	131	.9720	181	.9528	231	.9341
32	1.0112	82	.9913	132	.9716	182	.9524	232	.9337
33	1.0108	83	.9909	133	.9713	183	.9521	233	.9334
34	1.0104	84	.9905	134	.9709	184	.9517	234	.9330
35	1.0100	85	.9901	135	.9705	185	.9513	235	.9326
36	1.0096	86	.9897	136	.9701	186	.9509	236	.9322
37	1.0092	87	.9893	137	.9697	187	.9505	237	.9318
38	1.0088	88	.9889	138	.9694	188	.9502	238	.9315
39	1.0084	89	.9885	139	.9690	189	.9498	239	.9311
40	1.0080	90	.9881	140	.9686	190	.9494	240	.9307
41	1.0076	91	.9877	141	.9682	191	.9490	241	.9303
42	1.0072	92	.9873	142	.9678	192	.9487	242	.9300
43	1.0068	93	.9869	143	.9675	193	.9483	243	.9296
44	1.0064	94	.9865	144	.9671	194	.9480	244	.9293
45	1.0060	95	.9861	145	.9667	195	.9476	245	.9289
46	1.0056	96	.9857	146	.9663	196	.9472	246	.9285
47	1.0052	97	.9853	147	.9659	197	.9468	247	.9281
48	1.0048	98	.9849	148	.9655	198	.9465	248	.9278
49	1.0044	99	.9845	149	.9651	199	.9461	249	.9274

b. Road Mix Samples

Samples of the mixed product shall be submitted to the Helena laboratory for grading and extraction tests. Samples will be submitted in accordance with the following:

(a) 1½" mor or less—one per mile.

(b) Over 1½" mat—two per mile.

The half miles would be counted from the beginning of the project, and as being the first half or the last half of each mile. Care should be taken that the sample truly represents the material in the whole section; this can be effected by taking a number of small samples and combining them as a composite sample representative of the whole interval. (Form No. 97) will be used, the original going direct to the Testing Laboratory, the duplicate to the Division Office and the triplicate being retained in the field. The grade and source of the bitumen should be noted on the bottom of the form.

In preparing the sample for shipment the engineer will attach two shipping tags to the sack with information on the back thereof similar to that on the sample report form. All samples will be submitted direct to the Laboratory by express collect.

c. Field Laboratory Control.

Under ordinary conditions, all work is scheduled so that the Helena Laboratory can exercise sufficient control over the execution of the work, however, any unusual feature should be referred immediately to the Assistant Bituminous Engineer or the Testing Engineer for advice. If necessary, the Engineer will be furnished laboratory equipment and the specific instructions for the use of same. Sufficient equipment is contained in the field test kits (See paragraph 4,281), to maintain an adequate field control.

4.38 Traffic Protection

Oiling work imposes a temporary hardship on all traffic through the area. Every consideration should be given the motorist to the end that he will not be exposed to any hazard. Adequate warning signs should be erected and warning lights installed as directed in Paragraph 1.26 of this Manual and Section 23.8 of the Specifications. "Please Drive

Safely" cards, Form No. 122, have been provided, these to be presented by flagmen to the motorists. To warn the traffic when in the immediate vicinity of oiling work, the contractor shall erect portable stand "STOP" signs, these to be furnished by the State and placed about three hundred feet from the flagmen. The flagmen will be equipped with red flags to stop the traffic and present the cards. The flagmen should be prepared to tell the distance between the termini of the work, the condition of the area, the amount of equipment on the road and other items which would be of benefit to the traveler. It is very essential that the flagmen exercise tact and courtesy in their relations with the public.

4.39 Estimates All entries pertaining to road-mix oiling should be noted in the upper half of the estimate blank, pages 2 and 3. The total to date would be noted as directed for other construction items. The estimates should concur as to quantities with the data submitted on the weekly oil reports.

4.4 Plant Mix Oiling The control and regulation of Plant Mix Oiling is similar to that of Road Mix Oiling. The process is governed, in the main, by the materials at hand in the various districts throughout the State, hence no specified method has been incorporated in the Standard Specifications, special provisions being written to suit the conditions existing in the vicinity of each contract awarded. The engineer on assignment to Plant Mix Oiling should study carefully the Special Provisions governing, and all features of the work that would come within the scope of the Standard Specifications.

4.41 Materials The Special Provisions, as stated before, are written to suit local conditions, so ordinarily the Testing Laboratory has knowledge of all pits proposed for use. On award of the contract and decision of the contractor as to the source of aggregates the engineer should submit a check sample of the mixed aggregate as existing in the pit. When the aggregates have been crushed and screened, prior to being oiled, the engineer should sub-

mit samples of the graded aggregates, stating the proportions existing in the pit as based on the analysis of the mixed aggregate check sample. The Laboratory will then design an ideal mix to govern all subsequent oiling operations on the project, this mix of course, being subject to any subsequent changes in grading manifested in the pit. Operations in the pit should be so executed that a uniformly graded product will be delivered to the bins. In the event that foreign material, in most cases filler, is added to the aggregates, it should be blended at a trap where, knowing the grading of the materials on the conveying belt, the operator can accurately apportion the filler to guarantee a well graded product in the bins.

4.411 Proportioning In proportioning the graded materials, the fine aggregates and the rated fineness of the dust or filler therein will govern the amount of oil to be used. It is essential therefore, that these materials be regulated accurately to produce a uniform product. Carry-over to the coarse bin should not be allowed and in no case should the field mix be designed on the basis of an estimated amount of carry-over to the coarse bin.

4.412 Design of the Mix The "ideal" mix as designed by the Laboratory, is, of course, predicated on the samples submitted prior to oiling. To maintain a uniform product, the engineer should analyze the dry aggregates at least once a day or at any time in which a change in the composition of the materials in the pit is noticed, generally through change in color of the oiled product or shortage in either of the bins. A controlling field mix would then be designed according to the following formula. However, the percentage of oil should not exceed 4% in most instances, and further, the analysis of the aggregates should, of course, come within the limits specified by the "Gradation Table" in the Special Provisions.

The McKesson Frickstad formula is used to determine the required oil content as based on the gradation of the aggregates. The original formula has been modified for use in Montana to add 25% and will be presented herewith:

Formula

$$P=1.25\ (.015A+.03B+.17C)$$

Where P=Percent of oil.

A=Percent of aggregate retained on 10 mesh.

B=Percent of aggregate passing 10, retained on 200 mesh.

C=Percent of aggregate passing 200 mesh.

For convenience in field application and the use of the chart following, the formula is reduced to the form shown below.

$$P=1.25\ \left[.015A+.015\ (2B)+\frac{.015\ (34C)}{3}\right]$$

$$=1.25\ \left[\frac{.015\ (A+2B+34C)}{3}\right]$$

The chart following is based on the total number of parts by percentage as expressed by A, B and C and the maximum and minimum oil content required for the aggregates combined in whole according to the gradation limits in the Specifications.

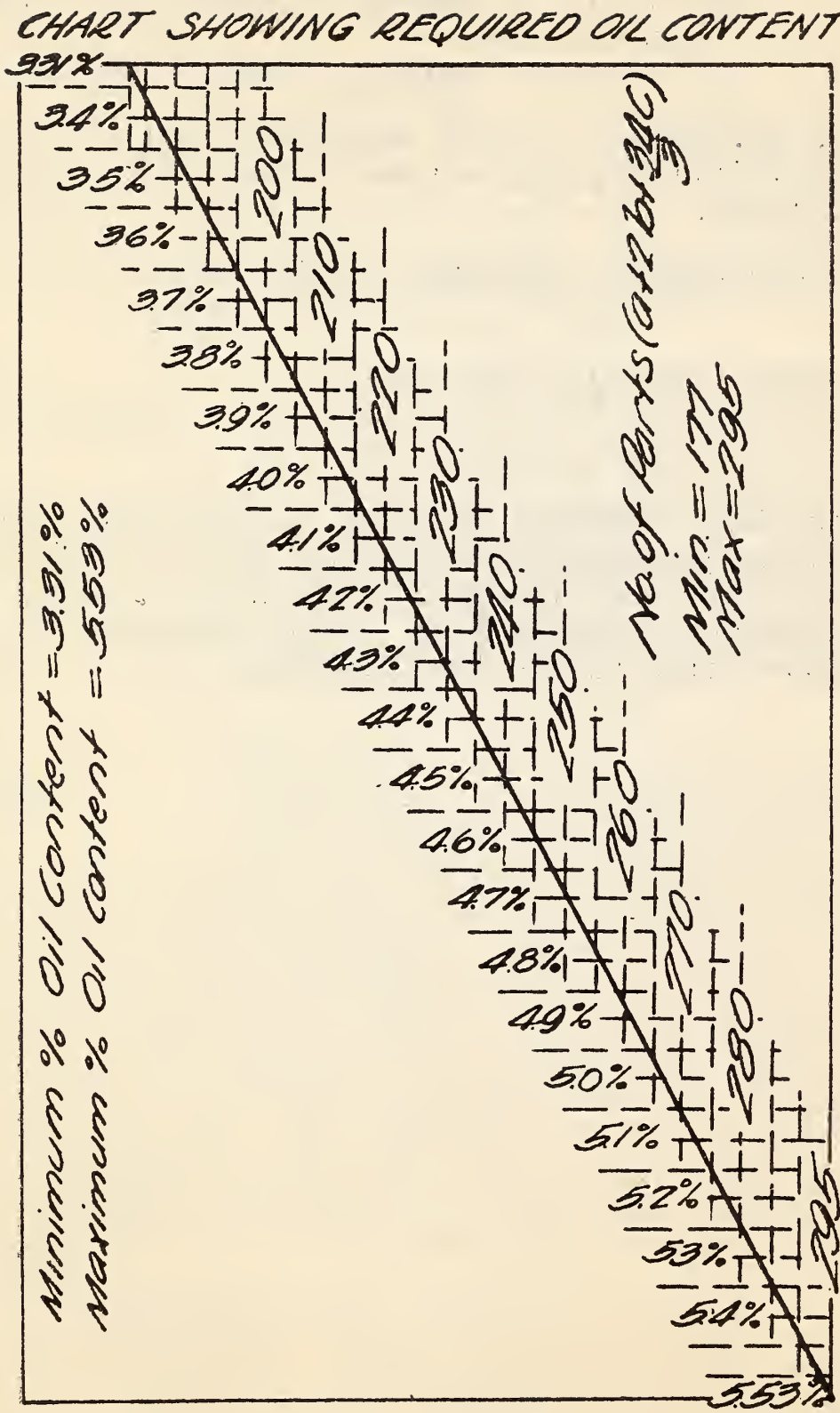
CHART SHOWING REQUIRED OIL CONTENT
93%
34%
35%
36%
37%
38%
39%
40%
41%
42%
43%
44%
45%
46%
47%
48%
49%
50%
51%
52%
53%
54%
55.3%
200
210
220
230
240
250
260
270
280
290
300
305
No. of Barks (Strokes)
MIN = 111
MAX = 305
MINIMUM % OIL CONTENT = 33.1%
MAXIMUM % OIL CONTENT = 55.3%

To illustrate the use of the chart, the example set forth in Paragraph 4.2832 will be used as a basis for a plant mix design. The separation then would be 48% in the coarse bin and 52% in the fine bin.

Bin No	−¾	+¼	−¼	+10	−10	+40	−40	+200	−200
1	100%	48%							
2			52%	9.88%	42.12	16.12	26.00	16.64	9.36

The derivation of the bases A, B and C would be as follows:

A=the material, by percentage, retained on the 1¼ inch screen plus the percentage passing the ¼ screen and being retained on the 10-mesh sieve. In the example this would be (48+9.88)=57.88.

B=the material, by percentage, passing the 10-mesh sieve, less the material passing the 200-mesh sieve. In the example this would be (42.12—9.36)=32.76.

C=the material passing the 200-mesh sieve; in the case of the example 9.36.

The number of percentage parts is expressed as $\frac{(A+2B+34C)}{3}$.

In the example, this would be as follows:

$$\begin{aligned} 57.88 \times 1 &= 57.88 \\ 32.76 \times 2 &= 65.52 \\ 9.36 \times 34 &= 106.08 \\ \hline 3 & \\ 229.48 & \end{aligned}$$

To procure the required oil content by percentage, the operator would point off from the left of the chart to the point where the total number of parts $\frac{(A+2B+34C)}{3}$, would intersect with the straight line equation; in the example, this would be at 229.5+ and would indicate that the required percentage of oil by weight, would be 4.30%. The use of the McKesson Frickstad formula serves in most cases to set a satisfactory percentage of oil in the mix design. Ultimate satisfaction depends on local conditions and the results obtained

by use of the formula can be modified, as required, to procure a properly treated aggregate.

Having set the required oil content by percentage, it now remains to set the weights in proportion, at the plant scales. It is to be noted that the oil percentage set by use of the formula is based on the total combined weights of the dry mineral aggregates. The total batch, in factors of percentage, would then be 100% (the combined weights of the dry aggregates) plus the required oil content by percentage. Weights would then be computed as shown by the following equations:

$$\text{Weight of Oil} = \left[\frac{A}{1+P}\right] P$$

$$\text{Weight of Coarse} = \left[\frac{A}{1+P}\right] C$$

$$\text{Weight of Fines} = \left[\frac{A}{1+P}\right] F$$

Where A=Total Weight of Batch Proposed.
P=Percent of Oil.
C=Percent of Coarse Aggregate.
F=Percent of Fine Aggregate.

Continuing the example; it is proposed to set the scales for a 2,200 pound batch, the oil content to be 4.3% and the fine aggregate and the coarse aggregate to be rated at 52% and 48% respectively.

For the example $\frac{A}{1+P} = \frac{2200}{104.3}$

$= 21.093$

Weight of Oil	$= 21.093 \times 4.3$		
	$= 90.6999,$	Say	90 lb.
Weight of Coarse	$= 21.093 \times 48$		
	$= 1012.464,$	Say	1015 lb.
Weight of Fines	$= 21.093 \times 52$		
	$= 1096.836$	Say	1095 lb.
	Total Batch Weight		2200 lb.

4.413 Suitable Oil Content A satisfactory plant mix product can be distinguished according to the directions in Paragraph 4.335.

4.421 Mixing Bituminous products, when introduced to the dry aggregates, will tend to coat the fine materials first and then the fine materials in turn will conduct the stain to the coarse aggregates. With this in mind, therefore, the Inspector should see that the oil flow to the pug mill is so regulated that all the materials will be suitably coated. No "whites" should be allowed in the mix on delivery to the truck. The best method of mixing can be ascertained at the plant, due consideration being given to effecting a time saving for the contractor.

4.422 Placing On delivery of plant mixed material to the project the sequence of operations is similar to that given for road mix oiling, the Special Provisions governing, of course. Care should be taken that no base material along the shoulders be incorporated in the mix to change the composition. A suitable appearance on completion is essential and the lines for the edge of the mat shall be staked.

In hauling heavy bituminous mixtures over the prepared subgrade, the engineer should check the foundation for any indication of weakness and correct it before the mat is placed.

4.423 Moisture Moisture is driven from the mixed aggregate by use of a dryer; however, in the interests of speedy production the material is sometimes fed too fast through this unit of the plant with an ultimate detrimental effect on the mix at the pug mill. A mix with excess moisture content will manifest itself by a glistening appearance and if handled will leave, in addition to the bituminous stain, a slight trace of water on the palm of the hand. A material suitable to treat with oil will not compact when handled. The Inspector will be provided with sufficient apparatus to maintain an adequate control of this feature of the work. Failures from excess moisture content are not generally apparent until after the mix has been laid down about ten days, hence the control of this feature of the work at the plant is of utmost importance.

If water enters the mixture in transit or when dumped on the roadway, the materials shall be dried as specified in Section 23.3 of the Standard Specifications.

4.424 Rolling The procedure in rolling is similar to that outlined in Paragraph 4.344. Consideration should be given the use of a roller as a means to compact the subgrade prior to placing the surface coat.

4.43 Reports The preparation and submission of reports shall be conducted according to the directions set forth in Paragraph 4.35. The weekly oil report (Form No. 21) will be similar to that presented on a Road Mix project except as modified below:

a. Show total gallons each mile but do not show the tons placed each mile; the total tonnage each week and the total tonnage to date should be shown, however. In case there are stock piles, the gallons of oil and the tonnage therein should be shown in the "Remarks" column; these totals will also be shown as the weekly totals and the total to date.

b. All invoices and business pertaining thereto will be conducted as directed in Paragraph 4.35.

c. Shipping notices, as in Paragraph 4.35.

d. Contractor's Orders, as in Paragraph 4.35.

e. Carload Record, as in Paragraph 4.35.

4.44 Inspection and Field Control Inspection provided on Plant Mix Oiling should be consistent with the results anticipated on completion.

A satisfactory riding surface is demanded and the constituents in the mix should be assembled to meet the demands of the specifications, however, the inspection should not be so rigid that the process will lose its value as a means of providing an economical surface.

4.441 Plant Inspection

a. Weights.

Properly proportioned weights are dependent, of course, on accurate weighing devices and the plant scales and the platform scales are c be tested and approved by the State Scale Inspector prior to starting work.

During the course of construction, the plant scales and the platform scales will serve to check each other as a sufficient control of this feature of the work. If there is a deviation of considerable extent between the plant weights and platform scale weights, the scales should be re-tested and corrected.

The asphalt bucket should be adjusted for tare constantly, inasmuch as the dust around the plant will be attracted by the road oil as it enters the bucket.

b. Records.

Normally the inspector at the plant will fill out the tickets (Form No. 124) and hand the original and duplicate to the truck driver and retain the triplicate. At the end of the shift the inspector should summarize the tickets to show the quantities by weights of the aggregates and the bituminous material. The number of batches multiplied by the weight of the oil set for each batch would then determine the weight of the oil used during the shift. The weight would then be reduced to gallonage. The tonnage for each truck during the shift would be computed for convenient entry in the notebook.

The oil on hand including all carloads at the siding and at the plant should be measured by the inspector and shown on the daily summary as a check of the estimated gallonage used during the day.

All cars received and released should be noted on the daily summary.

4.442 Point of Delivery

The inspector at the point of delivery shall be presented with the duplicate ticket to keep as a part of his records. All loads shall be staked accurately as to the "pull" ordered by the engineer. The field inspectors will also be charged with procuring samples and supervising the work of rolling, preparing the subgrade, etc. On completion of the shift he will assemble all the tickets and combine them with those of the plant inspector for entry in the notebook. In addition to showing the station to station interval for the shift, the field inspector should segregate the loads by tonnage according to miles.

4.443 Materials Inspection

In addition to the inspection maintained at the plant scales and at the point of delivery, an inspector will be assigned to exercise control of the

gradation of the aggregates, the regulation of the oil proportion in the mix, and the moisture content. Under most conditions, the Project Engineer or the Head Inspector will set the proportions of aggregate and oil and the inspector detailed to control the materials will regulate his work on the basis thus established. The Manual has treated with the methods approved in checking the gradation of aggregates and the control of moisture. (See Paragraph 4.2832). Moisture content can be ascertained by heating a sample of the aggregate to a constant weigh at 110°C (230°F) and comparing the resultant weight of the sample with the original weight.

4.45 Notes All notes pertaining to Plant Mix Oiling on the project, should be entered in the "Surfacing" notebook. As in Road Mix Oiling, the weekly report constitutes a complete record of the work. Other notes would be essentially as follows: cars received and temperatures thereof, weather conditions, station to station intervals, samples submitted, field screen analyses, etc. In order that these be consolidated and a check on plan quantities be maintained, the following forms are recommended.

TONNAGE

Left Hand Page

Sta. to Sta.		Tr. No. & Capacity	Total Tons Day	Total Tons to Date	Plans Tons Total

The notes would be made up from the data submitted by both the plant inspector and the inspector at the point of delivery. Sta. to Sta. data from the inspector at the point of delivery.

Tr. No. & Capacity — from the plant inspector.

Total Tons Day — from the plant inspector.

Total Tons to Date — the day's run added to the "total to date" the preceding day.

Plans Tons Total — The theoretical quantity to date as based on the tonnage designed per station on the plan.

Right Hand Page

Over or Under	Gallons Used	Total Gallons to Date	Remarks

Over or Under — The comparison of the "Plans Tons Total" and the "Total to Date.

Gallons Used — from the plant inspector.

Total Gallons to Date — from the plant inspector.

Remarks — Batch proportion weights and if changed in a shift show where used, weather conditions, samples submitted, screen analyses, and any other salient features.

Quantities for seal coat, tack coat, rolling, watering, car load record, etc. would be entered under their classification in other parts of the book, proper heading being provided so that the totals can be ascertained instantly.

All notes, in addition to showing the quantities in the station to station intervals should also be totaled according to miles for convenience in preparing the weekly report.

4.46 Laboratory Control — Any doubt as to the proper proportions to use in designing a mix should be referred instantly to the Testing Laboratory. Speedy and immediate cooperation with the laboratory is essential to procure satisfactory results. The preparation and submission of samples for a Plant Mix project is similar to that outlined in Paragraph 4.37.

4.47 Traffic Protection — See Paragraph 4.38.

4.48 Estimates All entries shall be shown on the upper half of Pages 2 and 3 of the estimate blank. The gallons entering in the mix shall be shown where convenient and according to the divisions shown for the tonnage.

4.5 Bituminous Concrete Bituminous concrete is usually specified for urban areas and when placed the plant operations such as proportioning the aggregates and the bitumen, are subject to the control outlined in the Standard Specifications supplemented by Special Provisions which also constitute the basis for field control of the work and when assigned the engineer should study carefully. all phases applying.

4.51 Preliminary Operations

4.511 Subgrade To achieve success with asphaltic concrete paving, a firm foundation true to line and parallel in cross-section to the finished grade should be supplied. In the case of a resurface job over old paving, the binder or leveling course should be placed to a staked grade so that there will be no occasion for unequal compaction when the wearing course is laid.

4.512 Priming The surface of the base as presented for the wearing course should be primed to facilitate cohesion. The priming coat consists of an asphalt cutback with a volatile solvent and it should be applied in a fine spray; in this particular use the bituminous material could be considered a lubricant and an excess of asphalt will provide a plane of slippage. A priming coat when applied correctly will have a black sheen and the primed surface will be uniform in color. No part of the wearing course should be placed on the primed base until such a time that the solvent has left the priming substance.

4.513 Forms In setting forms it has been found practicable to put in grade stakes at the full and half stations on tangents and a straight grade. On vertical curves and horizontal curves grade stakes should be placed at 25′ intervals. Line stakes should be set at 100′ intervals on tangents

and at 25′ intervals on curves. The stakes should be offset two feet from the edge of the finished mat. All grades shall be set to hundredths.

When setting the forms the engineer should see that the form lines present a symmetrical appearance both as to line and grade. In many cases the standard run-off should be changed to an extent pleasing to the eye, this is especially true where vertical curves are present along the alignment described by horizontal curves.

Construction details covering the composition of the forms and the preparation of the subgrade prior to installing the forms will be governed in the Specifications.

When ready for paving the variation in the forms as to grade should not exceed the limits specified for the riding surface.

4.52 Hauling The mix when delivered to the trucks will be hot, however, if the haul to the project is of such length that cooling and resultant caking are apparent, tarpaulins should be provided to retain the heat. A proper schedule should be maintained so that no trucks will be kept waiting at the point of delivery.

4.53 Leveling In placing the material, it is presupposed that the preparatory work will have been of such exactitude that knowing the "pull" of each load the materials will be distributed in courses of regular depth. If the load does not "pull" to the computed yardage, the base should be checked for irregularities. It is essential that the material should be laid in the vertical dimensions given in the plan to preclude any chance of unequal compression when rolled.

4.54 Spreading

4.541 Forking When delivered to the project the material should be dumped about one-half the length of the computed "pull" ahead of the last raked course. The material should then be carried back and ahead to the extremities of the "pull" by asphalt forks, care being taken that each forkful be turned over when placed. Special attention should be given to turning over the material as this

action tends to restore the mix to the gradation of the load at the plant, thus forestalling the presence of any rock pockets or "fat" spots.

4.542 Raking While the mixture is being forked in place it will be raked to the plane indicated for each course. This act of raking is one that demands a knack, acquired through years of practice and all rakers should be qualified to the engineer as entirely competent. One of the rakers should be detailed to check the grade constantly for any irregularities due to unequal compression after the first rolling or a variance in materials. The same raker should be detailed to prepare the joints on completion of a day's work and to make the joint on resumption of work the following shift. The finishing course when raked should be rolled immediately and the surface checked for irregularities. Any departure in grade over the limits specified should be repaired usually by "skin patching," i. e., rake fine materials in the depression and roll immediately.

4.55 Rolling Rollers are used as a compacting agent, however, improper procedure and incompetent handling will tend to compress the course unequally and thus allow errors to enter in the finished grade.

The Special Provisions and Standard Specifications do not cite that two rollers are required for bituminous concrete paving, however, the instructions following, for the sake of exemplification, will relate to conditions where there is plant production in sufficient quantity to warrant the use of two rollers. The instructions can be modified to suit local conditions, it being the intent to outline the procedure or sequence in rolling rather than the equipment to be used.

Rolling should not be started until the material has cooled to a point where setting up has begun.

4.551 Base and Levelling Course The rolling of the base and levelling course should be done with a three-wheeled roller along the length of the course. If on a pronounced gradient the roller should be backed uphill. All rolling should start at each edge of the mat and proceed in half lap intervals of the outside rear wheel to the center of the roadway. In leaving the hot mix area the roller should retrace the entrant tracks. All

turning should be done on a cooled surface and all stops, when in the hot mix area, should be staggered to prevent a transverse stop mark across the width of the paving. The speed of the roller should be regulated so that no jerk and consequent depression will be apparent when the directions are reversed.

4.552 Wearing Course The initial rolling shall be effected in a manner similar to that described above, i. e., straight rolling with a three wheel roller. During the time of the initial rolling, the surface shall be checked and "skin patched," also any transverse bumps of any extent should be marked for correction by the tandem roller. When the initial rolling is completed the tandem roller will be used to cross roll, it being intended that all transverse irregularities will then be removed. On completion of the "cross rolling," straight rolling will be resorted to, either by the three wheel or tandem and continued until the mat shows no movement under the wheels.

4.56 Inspection Plant inspection as stated herebefore will be effected according to the control of the Special Provisions and Standard Specifications. Field inspectors should be delegated as follows:

a. One man to check the loads in place.

b. Two men to stake out the "pulls" and to check the surface course for grade.

4.57 Notes All notes pertaining to the work should be entered in the "Surfacing" notebook. The notes shall be in the general form used for "Plant Mix Oiling," Paragraph 4.45.

4.58 Laboratory Control Laboratory Control will be effected by the inspectors at the plant. If any mixtures containing rock pockets or excess bitumen are delivered to the roadway, they should be wasted.

4.59 Estimates Entries will be made under substituted headings on the upper half of pages 2 and 3 of the estimate.

4.6 Portland Cement Concrete Paving Concrete paving, in the main, is a mechanical operation, consequently the methods have been standardized in

all engineering field books and the Special Provisions appended to the Standard Specifications on all paving contracts are clear enough to preclude any misinterpretation. All operations in concrete paving are dependent on perfect co-ordination. The Special Provisions outline the work and specify certain machinery and equipment.

A few points of minor detail will be outlined for the convenience of the field engineer.

4.61 Preliminary Operations

4.611 Subgrade Ordinarily paving work is let as a separate unit from the grading work thus allowing traffic compaction. In some cases, due to unequal settlement the grade as presented for paving will differ somewhat from the plan grade. The engineer should re-run a profile and lay a new grade to an elevation so that the trench excavation will furnish adequate shoulder material. Consideration should also be given in this operation to reinforcing the subgrade at any points which indicate weakness.

Forms
4.612 See Paragraph 4.513

4.6121 Fine Grading An integral part of setting the forms is the act of fine grading. The control of all the work depends in part on the precision attained in this phase of the work. Equipment now available if used with the side forms prevents all deviation from the staked grade plane. Some judgment is required in estimating the probable compression when the grade is rolled. In no case should the excavation be carried to an elevation below that shown on the typical section.

Fine grades when compacted by the roller will yield from ¼" to ½".

4.6122 Maintenance Materials when hauled to the mixer will of necessity be hauled over the fine grade and the hauling interval thereover should be minimized to prevent undue wear. All ruts and depressed areas as they appear shall be restored to the proper elevation. Sprinkling should be continued far enough in advance of the paving to prevent dust or loose material accumulating on the fine

grade. The grade should be checked with a template at all times, however, the checking should be done far enough in advance of the paver that the contractor's force will not be hindered in their work.

If, at any time, rains occur in an amount sufficient for surface water to collect on the grade, provision should be made as determined by the gradient to drain it off under the side forms.

Hair checking in newly finished concrete can be attributed to two factors; 1. a dry subgrade which will draw water from the paving mixture, and (2) highly absorptive atmospheric conditions. Needless to say, the first condition can be nullified if the fine grade is properly maintained. The second condition can be nullified by use of proper curing methods.

4.62 Mixing In mixing the aggregates, the laboratory weight control will govern. To guarantee satisfaction on completion of the work certain duties should be performed as hereinafter prescribed.

4.621 Estimating the Batch The manufacturer rates the mixer by the number of sacks of cement that can be combined with the aggregates to produce the concrete. In determining the size of the batch consideration should be given to the following:

a. All units must be co-ordinated, i. e., the bucket should be big enough to accommodate the batch without overloading, and in turn, the drum should be big enough to receive the material from the skip without spilling.

b. When the bucket is at the end of the boom, the mixer should remain stable.

4.622 Water Supply The water system provided should be adequate to supply both the mixer and the amount required for ponding, sprinkling the subgrade and for a light spray over the paved surface immediately after the initial set is perceived.

4.623 Proportioning Aggregates and the cement are usually proportioned by weights. General practice now is one part cement, two parts sand, and three parts gravel by volume, converted to weights. The limiting gradation of the aggregates is given in the Specifications. The fine and

coarse aggregates are weighed into the batch; under field conditions, however, compensation should be allowed for moisture content, usually up to 6% in the fine aggregate and 2% in the coarse aggregate. Any change effected at the plant to allow for water content should be equalized by a decrease in water allowance at the mixer.

Common practice at the plant has been to load the aggregates into the batcher from stock piles and care should be taken that the stock piles are worked in a manner that will produce an aggregate similar in weight and gradation to the sample submitted as representing the material. If the aggregates change in composition to such an extent that it is noticeable, the proportions should be reset to restore the grading to that shown on the screen analyses. This can be done by changing the weights proportioned for each aggregate, the increase in one aggregate to be compensated by a decrease in the other.

The materials used should be checked against the theoretical quantities required during any day's run to finally ascertain the correct volumes to be weighed out for each aggregate, it being presumed that the subgrade is graded to the exact cross-section designed.

4.624 Consistency The concrete on leaving the bucket should be consistent with the limits of slump prescribed in the Specifications. The amount of water introduced in the batch will govern the degree of consistency and the control of the water content in the mix is one of great responsibility. The concrete when placed should be uniformly consistent to avoid varying slump and consequent poor riding surface. If the batches are not uniform the inspector should seek the cause and correct it. A number of elements contribute to non-uniformity, chief among them being faulty or leaky water discharge valves, lack of sufficient water pressure, incompetent handling by the mixerman, changing weather conditions and as cited in Paragraph 4.623, a change in the moisture content and grading at the plant.

4.625 Delivery to the Skip Care should be exercised in delivering the material to the skip. If hauled in compartment trucks, the compartments should be separated by gates high enough to prevent one batch sloughing over into another. The same limits would apply at the skip when

the aggregates are dumped therein. Whenever cement is added, either at the plant or at the mixer, care should be taken that none is lost due to careless handling or wind.

4.626 Charging the Drum When the skip is raised see that all materials therein are conveyed to the drum.

4.627 Timing the Mixer The minimum time specified for mixing will, of course, govern in the paving operations. All paving concrete should be mixed until thoroughly coated.

4.628 Delivery to the Subgrade When delivering the mixed material to the subgrade, the bucket should be supported at an elevation sufficient to clear the joint installer and no higher. If, in the immediate vicinity of a transverse joint, the concrete should be deposited away from the joint and then hand shoveled against it.

Any waste concrete deposited under the discharge chute can be used, if spread uniformly over the subgrade.

If water collects in the thickened edge of the panel it should be drained completely before depositing any concrete.

4.63 Paving

4.631 Spreading When the material is discharged on the subgrade, segregation will take place in many instances. This will be corrected if the material is turned over by the hand shovelers. Care should be taken in depositing the material near the side forms and the joints. Proper provision should be made for spading the material against the forms, to prevent honey-comb edges.

In distributing the material do not allow the spreaders to walk over the spread as this tends to drive the coarse aggregate to the bottom of the panel. One or more of the spreaders should be assigned to keep a uniform windrow of material against the strike-off board of the finishing machine.

4.632 Finishing The finishing machine is fundamentally a compacting unit, therefore, enough material must be left ahead of the strike-off board to provide for compression. Any

depression left in the wake of the machine shall be filled with adequate material to restore the grade. Screeding tends to suck the mortar up from the bottom of the panel, hence it is advisable to discontinue the use of the machine immediately after a uniform surface as to grade and texture is obtained.

4.6321 Hand Finishing The Standard Specifications outline the sequence of operations and the use of all hand finishing equipment very clearly. The point to remember is that the traffic on the finished roadway will be along the length of the paving and any corrections for grade with rigid straight-edged tools should be effected at right angles to the centerline. The consolidating and finishing work effected by the finishing machine should not be invalidated by excess hand floating.

Brooming is done after the water sheen has disappeared or at any time in which the brush will leave a mark. The purpose of brooming is to provide a non-skid, light diffusing surface, and further, to take out all marks left by the hand finishing tools.

4.633 Joints Metal installing bars are now provided to set the joint filler and the dowels, and the installing unit must be left in place until all machine work is completed. When the hand finishing begins the installing unit will be lifted and the joints floated and edged against the channel cap left over the joint filler. Especial attention is to be given equalizing both sides of the joints when edging.

4.634 Curing Immediately after the initial set, the concrete shall be protected by laying burlap over the panels and sprinkling with a fine spray. This operation will in most cases prevent hair checking caused by rapid dehydration in the paving mixture. See Paragraph 4.622.

The burlap must be kept wetted until such a time that the concrete will support the final covering material, usually about five hours. Several acceptable methods are in use as a medium to effect a satisfactory cure, among them being ponding by the use of earth dikes, laying straw or hay, and covering the entire area with a layer of dirt. Any method used, however, is useless unless the whole area is thoroughly wetted down and kept wet for as long as the Specifications

specify. Improper curing will nullify all the care and hard work exercised through the operations of mixing, spreading and finishing.

4.64 Inspection & Records The engineering inspection can be divided in three classes, the engineer in charge, the plant inspector and the paving inspector. Their duties and functions are as follows:

a. Engineer in charge

General engineering supervision over all work to include the proportioning at the plant, setting stakes for the fine grading, etc.

b. Plant Inspector

The work of checking all batches out to the mixer devolves upon the plant inspector. Each load as it is weighed out shall be checked as to weight and grading, i. e., to see that the batches are uniform in composition. Tickets to serve as a record of the materials delivered to the project will be issued at the plant (Form No. 1.24), the original being handed the truck driver and the duplicate and triplicate being retained. All work in loading from the stock piles to the bin will be administered by the plant inspector to the end that uniformity in the components of each batch will be maintained.

Inasmuch as control of the work is dependent on correct weighing facilities, the scales should be checked according to the directions in Paragraph 4.441, as they apply in concrete paving and as stipulated in the Specifications.

On completion of the day's run, the plant inspector must report on all activities at the plant. The quantities listed on the tickets will be summarized to show the total for the day for each truck. If the proportions of the aggregates were changed, the report must be segregated to show the total quantities hauled for each proportioned aggregate. In all cases the batches will be proportioned according to the screen analysis shown by the controlling sample reports from the Testing Laboratory and these sample reports and numbers must be shown as a referral in giving the batch proportions. The report will be entered as a unit of the "Surfacing records. Computations will be based on the yield anticipated in square yardage as compared with the cubic output. Form for compliance, as follows:

Left Hand Page

Date	Tr No. & Capacity	No. Batches Day	Total Batches	Yield Day	Total Yield

Having set the weights for the aggregates, the "yield" for the day would be the number of batches for the day multiplied by the yield computed for each cubic yard of concrete. The "total yield" would be the grand total of the daily anticipated yields.

Right Hand Page

Controlling Lab. No.....—Fines @ 97.2 lb.
Controlling Lab. No.....—Coarse @ 105 lb.

Batch Proportions—7 sack batch

Fines—14x97.2=1360.8 lb.	
+6% moisture	1440.0 lb.
Coarse—21x105=2205	
+2% moisture	2250.0 lb.
Total Each Batch	3690.0 lb.
Cu. Yardage each Batch	1.03

(Harger & Bonney, page 1092)

The above is a sample batch proportioning based on a seven sack mix and extended to the total weight that would be weighed into each batch to compensate for moisture.

With the data given for each batch proportion the total batches for the day would then be extended to the anticipated yield on the left hand page of the notebook.

c. The road inspector is charged with the routine inspection at the mixer. In general he will see that all the demands of the Specifications are met both in the mixing and the placing of the concrete.

On completion of the run the road inspector is required to report the extent of the run and compare the theoretical yield (from the plant inspector's record) against the square yardage actually paved. Overruns

or underruns would then be expressed in factors of cement content. As a check on the plant inspector's figures, the cement sacks shall be counted. For convenience in identifying test cylinders, the paving inspector will also show the car in which the cement was received at the railhead.

The report will be entered in the "Surfacing" notebook and will, in reality, be a recapitulation and extension of the quantities reported in the plant inspector's notebook. The form recommended would be as follows:

Left Hand Page

Date	Sta. to Sta.		Square Yardage	Anticipated Yield	Under or Over

The "Sta. to Sta." interval should be based on actual chained measurements.

Square Yardage	From the field measurements at the completion of the run.
Anticipated Yield	This data will be procured from the plant inspector and will be checked by the cement count.
Under or Over	Comparison of actual yield and anticipated yield expressed as a cement content factor.

Right Hand Page

Total Square Yardage	Total Anticipated Yield	Under or Over	Remarks	

Total Square Yardage	Grand total of daily runs in square yards.
Total Anticipated Yield	Grand total of daily anticipated yields.

Remarks — To include the record of the weather, the extent of the curing, notes on the location of test cylinders and any other salient features of the work.

As specified for the records at the plant, the paving inspector shall segregate the quantities according to batches as the proportions are changed. Notice of a change in batch proportions should be given the paving inspector immediately to enable him to show the extent of the work done with each set proportion.

4.65 Notes — As outlined herebefore, Paragraph 4.64, the methods in recording the notes are given. In addition to these records a diary should be kept by the field engineer showing a running account of the work to include the aggregate proportions and the dates used, weather conditions, etc.

4.66 Laboratory Control — All materials entering the concrete paving shall first be approved for use by the Testing Department.

4.661 Cement — On any paving project of considerable magnitude, provisions are made by the Testing Laboratory to consign the cement from pre-tested bins and as each carload is sent out the field engineer will be advised (Form No. 95) as to the source of the material and the railroad car number. On receipt of the car at the siding, the car number and contents will be checked against the notice sent from the laboratory. For convenience in identifying materials in subsequent test cylinders, the cement as used from each car received will be checked into the pavement (See Paragraph 4.64, part "c").

If the contractor provides poor storage facilities on receipt of the cement, check samples should be submitted immediately to the Laboratory, no paving work being allowed until authorized therefrom. The same limits abide in the case where a local merchant is providing cement from stocks that have been in storage for a long time.

When sampling cement, a composite sample of seven or eight pounds should be assembled from smaller samples each representing forty sacks in the consignment.

4.662 Fine Aggregate Prior to any paving operations, a sample of the stock piled fine aggregate must be submitted for analysis and accurate weighing. The proportions of the aggregates, as stated before are dependent wholly on the weight figures per cubic foot as computed by the laboratory. Care is to be taken in submitting the sample that it is truly representative. If, in the course of the work, the gradation of the material changes, with a resultant variation in the unit weight, a check sample should be submitted immediately to serve as a guide in succeeding batch proportion computations.

As stated before, special effort should be extended to regulate the loading of the material into the batcher to simulate conditions cited in each sample report from the laboratory.

The sample will be reported on Form No. 92 in quadruplicate , the original to be sent direct to the Laboratory, the duplicate to go with the sample, the triplicate to go to the Division Office, and the quadruplicate to be retained in the field. The sample will be sent by express collect to the Laboratory, the shipping tags to show information similar to that on the sample report form.

4.663 Coarse Aggregate The sampling and control of the coarse aggregate is similar to the methods outlined in the preceding paragraph. Coarse aggregate is graded from the ¼″ screen to the maximum specified opening and the intervening grades are more subject to change than in fine aggregate, consequently extreme care should be taken in sampling the material to secure representation. Coarse aggregate, when stockpiled, tends to segregate, the coarser rock working to the outside. The plant inspector should regulate the loading so that this coarse material will be incorporated in the batch in a manner similar to the gradation shown on the sample report from the laboratory.

4.664 Concrete Cylinders Concrete cylinders will be made by the Paving Inspector to represent each day's paving run. Form No. 93, Laboratory Form No. 4 will be made out to include all the detail requested thereon; this information will be procured from the records of both the

Paving Inspector and the Plant Inspector. Paragraph 6.359 of the Bridge Section of the Manual explains in full the procedure relative to making and storing the compression specimens.

4.665 Miscellaneous Samples of pre-molded joint filler, dowels, dowel sockets, reinforcing steel etc., when requested from the laboratory, shall be sent as needed.

4.67 Estimates Concrete paving quantities will be entered under the surfacing headings on Page 3 of the estimate.

4.671 Supplementary Agreements If, in the course of the work, the panels are thickened, usually to strengthen the paving over weak spots in the sub-grade, compensation should be afforded the contractor on the basis of the additional volume. A Supplementary Agreement would then be submitted at a unit price for the increased volume compatible with the contract price by the square yard. The additional item would be entered on the estimate in an adjoining column under the A.W.O. number.

CHAPTER V

INCIDENTAL CONSTRUCTION

5.1 General Incidental Construction involving the items of riprap, hand-laid rock embankment, under drains, metal ditch lining and flumes, wood slat snow fence, wood and wire guard rails is described in the Standard Specifications. These items, while of minor importance, are to be given very special attention in that they are exposed on completion and the neatness shown in the construction will very materially reflect on the ability of the engineer.

All notes pertaining to incidental construction should be entered in the "Structures" section of the notebook.

The separate items and special instances for control will be cited hereinafter.

5.11 Riprap Devote enough time to this item of construction to guarantee a workmanlike appearance. The staking notes should suffice as a basis for computation of quantities inasmuch as the specifications and the plan together will limit the thickness of the riprap.

5.12 Hand Laid Rock Embankment The same controls would govern as for riprap

5.13 Under Drains The control of all work pertaining to under drains is covered in part under Chapter III.

5.14 Metal Ditch Lining and Flume This item usually is installed as a part of an existing irrigation system and it is obvious that the grades of the new structure should conform with the established grade. Do not allow other than competent, skilled workmen to work on the structure.

5.15 Wood Slat Snow Fence Study is warranted in locating snow fence; local opinion and personal observation should be used to determine the appropriate setting to retard drifting snow.

In cases where the snow fence cannot be installed

on cultivated land until after the growing season and the balance of the project is completed, an informal acceptance can be tendered, governed however, by the following provisions:

a. The snow fence must be ultimately placed before the completion date set for the contract.

b. No payment for the snow fence will be made prior to installation.

c. The installation will be guaranteed by withholding $300.00 from any monies due on the semi-final estimate.

d. Final acceptance will be made only on completion of every item in the contract.

5.16 Guard Rail Guard rail in affect will not only protect traffic, but it will also add symmetry to the roadway. Care should be taken that the grade along the top of the posts will parallel the established roadway grade. In staking guard rail it is suggested that the stakes be set to describe the inside face of the posts, the posts would then be sent 30 inches ahead of each stake thus leaving a semi-permanent reference for each post.

The painting should be done at a time when the dust on the roadway is laid by rains to guarantee an attractive appearance.

5.2 Urban Construction During the last few years the Highway Commission has been called upon to administer construction work in municipalities. Among other things the work has involved paving, the installation of sewage facilities, the adjustment of existing structures in the roadway and the building of curbs. Other features of construction will crop up according to the peculiarities of the area. It is obvious that the new work must be done to conform with the established grades and contours. General controls are given for common items of city work in the following paragraphs.

5.21 Paving Paving grades at intersections should be extended to provide an easy connection to the improvement. If the paving is between curb lines, use the curb at all times as the grade control.

5.22 Sewage The Special Provisions will outline the installation of sewage facilities. The flow line grade on the plans is

in many cases subject to change due to underground service connections which cannot be determined on the location survey. The proper procedure then would be to open up a ditch of considerable extent, ascertain the location and elevation of the existing facilities and then lay a new grade to accommodate the new work.

Special attention should be given the back fill; see that it is compacted in a manner that will forestall all future settlement.

5.23 Existing Structures Most new work in urban areas involves the re-adjustment of existing structures. Care should be exercised that the structure when adjusted to the new grade is true both longitudinally and transversely. Surface drainage units along the gutter line should be placed to guarantee absolute drainage; if necessary, adjust these structures to an elevation somewhat below the planned gutter grade to assure satisfaction.

5.24 Curbs A curb when built true to line and grade will add materially to the appearance of the work. Be sure that the parking area between the curb and the sidewalk will drain to the roadway.

CHAPTER VI

BRIDGE DEPARTMENT

6.1 Organization and General Details

6.11 Bridge Engineer The Bridge Engineer is delegated to supervise all activities in the Department, including the design and the supervision of construction. All advices and communications to the field will be issued only under his authority or that of the State Highway Engineer and the Assistant State Highway Engineer. The Division Offices will serve as the channel for all correspondence.

6.12 Bridge Designing Engineer The Bridge Designing Engineer is in charge of all design work and such features of the construction work as will appear for referral. His directions to the field will be issued only under the authority of the Bridge Engineer.

6.13 Bridge Construction Engineer The Bridge Construction Engineer exercises general supervision over all bridge construction work. His immediate superior in all matters of administration is the Bridge Engineer and he will act on authority emanating therefrom. Any suggestions or orders delivered to the field should be referred through the office of the Division Engineer.

6.14 Division Engineers The Division Engineers will control all bridge construction work in their districts, subject to the advice and direction of the Bridge Engineer. The work is highly specialized and any contingencies encountered affecting the design and satisfactory completion of the structures should be referred to the Bridge Engineer for final conclusion.

6.15 Resident Division Bridge Engineers Resident Division Bridge Engineers are assigned each division and through them the Division Engineers will maintain a direct control of all work within the division. All communications and orders will be given on the authority of the Division Engineer, and all points of

contention will be referred thereto for conclusion or transmittal to the Bridge Engineer. If such extenuating circumstances arise that it is necessary for direct communication with the Headquarters Office, copies thereof should be tendered the Division Engineer.

6.16 Resident Bridge Engineers Resident Bridge Engineers are placed in direct and intimate control of the bridge construction work and will act in accordance with the instructions directed through the Resident Division Engineer from the Division Engineer. Weekly reports and other routine office work will be directed to the Division Office.

6.17 Project Bridge Engineers Project Bridge Engineers are directed in their work as outlined above for the Resident Bridge Engineers. The Project Bridge Engineers will serve, however, on those structures which do not require such a specialized knowledge of the work.

6.18 Bridge Inspectors Bridge Inspectors will serve on structures as required under the direct supervision of the Resident Division Bridge Engineer.

6.19 Staking Parties Staking parties will be assigned as needed by the Division Engineer. They will ordinarily be "borrowed" from the Road Construction Department, but while on the work, will be subject to direction by the Resident Division Bridge Engineer or his authorized job inspector.

6.2 General Details

6.21 General Presuming that the location survey of a bridge site is accurate and correct, the design is correspondingly precise and the limits established by the plan drawings would control on the construction work. The chief elements entering in bridge inspection are then a complete knowledge of the design and a thorough knowledge of the Standard Specifications as they relate to procedure and the materials comprising the structure. Certain instructions have been issued in the past to interpret the specifications or to expand the knowledge and di-

rections contained therein and these will be assembled hereafter as a guide in the construction engineering work.

6.22 Referral The supervision of both road and bridge work is susceptible to comparison on the basis of general policy and office routine and the engineer is referred to the construction section of the manual as it treats with general details. Some of these topics will be amplified to explain their particular application to bridge work.

6.23 Estimates Refer to paragraph 1.21 in the construction section.

6.231 Procedure Bridges are composed of units or component parts and the following limits will prevail in preparing the progress estimates:

(a) Steel Spans: No allowance whatever shall be made for a span before it is completely pinned and bolted.
For steel erected, pinned and bolted, allow 80% of the weight.
For steel erected and riveted, allow 90% of the weight.
For steel erected, riveted and painted, allow 100% of the weight.
Proportional parts may be allowed for riveting and painting.

(b) Structure Excavation: Allow the actual quantity of the work performed, unless in your opinion there is a reasonable possibility of losing the hole because of poorly constructed cofferdams, possibility of flood conditions, or other factors.

(c) Concrete in Piers and Bents: Allow the actual quantity of the concrete in place except in cases as outlined under "Structure Excavation."

(d) Work by Agreement: Work performed under Supplemental Agreement may be shown on progress estimates. This work is treated like any contract item, that is, the amount of work performed to the estimate date may be paid for, whether the item be complete or not. Do not confuse Supplemental Agreement work with Force Account Work. Force Account work cannot be paid for until the Final Estimate.

(e) All Other Items: Allow the actual quantities in place unless unusual circumstances indicate this course to be unsafe.

Segregation Earnings Periods Objective Page 1 of the Estimate Pages 2 and 3 of the estimate	Refer to Construction Section

6.232 Descriptions Most items contained in a bridge contract will be shown on the lower half of pages 2 and 3 of the estimate blank, basic headings being provided in most instances.

6.233 Contingencies Refer to Construction Section.

6.234 Supporting Data for Finals Refer to Construction Section for applicable methods. The final estimate constitutes a complete record of all work on the bridge contract. The following explanations and examples are incorporated in this section to show the approved methods to submit the supporting data for the finals:

Comparison Sheet (one copy for each copy of the final estimate)
Original Additional Work Orders
Construction Notes, computations, and diary
Construction plans (3 sets)

6.2341 Comparison Sheet A tabulated comparison of project agreement and final quantities is required by Federal regulations to accompany the final estimate and its purpose is to present a composite picture of the differences between the planned and actual constructed quantities, giving an adequate explanation of any and all underruns or overruns. The tabulations should be on full sized (8½"x11") sheets with one copy for each copy of the final estimate.

Example:

Item No.	Classification	Unit	Proj. Agmt.	Final Quant.	Under	Over	W.O. & Amt.	Remarks
			(a) One Conc. Br. over 20′ span					
1.	Class "A"Conc.	cu. yd.	96.0	110.3	.....	14.3	No. 1 15 cu. yd.	See Note No.1
2.	Class "D" Conc. etc.	cu. yd.	126.0	126	.....	.....	.....	.....
			(b) Three Tr.Timber Bridges less than 20′ span					
7.	Tr. Lumber	MFBM	20.62	20.454	.166	.....	.....	See Note 2
8.	Untr. Lumber etc.	MFBM	2.34	2.337	.003	.....	.....	See Note 2
	E.W.O. No. 1			$127.15		$127.15	$154.00	See Note 3

Note 1: A hard Stratum of cemented gravel was encountered 3 ft. below plan grade, therefore the footings were lowered to obtain the desired bearing value.

Note 2: The 2"x4" decking pieces were slightly thicker than the 1⅝" dimension used for estimating, therefore, fewer pieces were required than estimated.

Note 3: Since it was impossible to obtain desirable foundation material for the footing of Pier No. 2 of the bridge at Sta. 220+50, it was deemed advisable to drive piling to get the desired bearing value. A satisfactory price could not be obtained from the Contractor, resulting in the force account work. The underrun was due to the fact that the estimated penetration could not be obtained and less piling was used than anticipated.

All of the sections (such as (a) and (b) of example) of the project agreement estimate should be shown on the comparison sheet completely itemized with separate explanations for each section. However, if the differences for the same item in each section can be covered by one general note, then cross-referencing is satisfactory.

The explanations given for any of the items for which additional work orders were issued must be complete; this can best be effected by quoting the work order as a sufficient reason for the overrun or underrun in part. Additional Work Orders should appear only by number and quantity in column as shown in "example". In case Additional Work Orders list quantities for which a supplementary agreement has been written, then such quantities are listed as separate items under "Work by Agreement," and the quantity would be considered primarily as an overrun, however, the explanation would treat with the underrun or overrun as based on the quantity set up in the work order.

All Extra Work Orders should be shown as monetary amounts. The explanations should give a brief statement of the work performed, why necessary, and explain any difference between the amount of the order as issued and the final cost.

6.2342 E.W.O's. Time Refer to Construction Section.

6.235 Exceptions The information contained in this topic in the Construction Section is particularly applicable in the Bridge Department and the special attention of the engineer is directed thereto.

6.24 Notebooks A day by day diary must be kept on all projects and forwarded to the Helena Office with the final estimate. This record should show the actual construction operations and a brief summary of the orders or suggestions verbally made to the Contractor.

The construction notes must be complete and consequently kept up to date. All necessary explanations should be given in order to facilitate the checking of the final quantities in the Helena Office. Also, in case a transfer of engineers should become necessary during the construction of the project, no difficulty will be experienced by the new inspector if the construction notes have been carefully kept. Loose leaf notebooks shall not be used.

6.241 Piling Records for Timber Bridges A driving record of all piling shall be kept. The record shall be submitted to the Division Office in duplicate, one copy being forwarded to the Bridge Department. Bents shall be numbered 1, 2, 3, etc., and Bent 1 shall be the end bent of the smaller stationing. Both end bents shall also be marked, north, east, south, or west, as the case may be. Piles shall be numbered from left to right, the extreme left piling being designated as No. 1. The type of hammer and the weight of the striking part shall be given, and in the case of a double-acting steam hammer, steam pressure and the area of the piston shall also be listed. The following data on each pile shall be tabulated:

Length of pile used (in feet)
H=Fall of hammer minus twice the height of bounce (in feet)
Penetration for last 5 blows (in inches)*
S=Average penetration per blow (in inches)
P=Safe load per pile (in pounds)
Pile length below cutoff (in feet)

Pile penetration (in feet)

*10 to 20 blows where steam hammer is used

(See page 74 of the Standard Specifications for formulae)

6.242 Records of Foundation Piling Make a sketch showing piles and number in the order driven. Tabulate all data as required under "Piling Records for Timber Bridges".

6.243 Timber Lists for Pile Bridges A field check shall be made of the number and size of pieces used in each structure. The quantities allowed shall be on the basis of the shortest commercial lengths of sticks from which the pieces can be cut. The timber list and computation of quantities shall be forwarded to Helena with the final estimate.

6.244 Structure Excavation Care shall be taken in setting down the elevations of the existing ground surface in order that the notes will be intelligible to the person checking the computations for the final quantities to be allowed.

All notes as prepared above should be entered in the "Structures" notebook.

6.3 Bridges

6.31 Field Procedure Satisfactory bridge construction is dependent in whole on accuracy and knowledge of details and the inspector is again referred to the plans and specifications for study.

6.311 Staking Out Generally speaking, all staked lines for reference should be along those lines established for the working lines of the structures. Locate all references to preclude any possibility of being disturbed or removed during the course of construction. In this connection it is well to observe that the reference hubs should be so conveniently located as to facilitate re-staking during the work.

All structures should be staked out as far in advance of the beginning of construction operations as possible. The Resident Division Bridge Engineer should be present when the structures are staked out, if possible, and the Bridge Inspector or Project Bridge

Engineer should always assist in staking out the structures he is to supervise.

It may be that a slight shifting of the bridge is desirable, especially on timber trestles. This may be due to changes in the profile from floods, occurring after the making of the survey, or from conditions not apparent on the survey. In some cases, a slight revision of the structure may be necessary in order to fit the existing conditions, and if the bridges are staked out sufficiently in advance of the beginning of construction, the required changes can be made without delay to the Contractor.

It should be borne in mind that a thorough study of the design was made when the plans were prepared and needless changes should not be requested. On the other hand, it is inexcusable to construct a bridge exactly according to stationing and details when it is obvious that a slight change will greatly improve the fitness of the structure.

Any major change in stationing or details should be reported to the Helena Office for concurrence before construction begins. In all cases, a full report shall be submitted.

In staking out grade separation structures, it should be remembered that certain vertical and horizontal clearances must be maintained. The skew angle and elevation of the rails must be checked, and in case the data shown on the design plans is incorrect, the structure must be staked out to fit the existing conditions. Grades and alignment should be computed from the track rather than from plan stationing.

6.32 Foundations All foundations for concrete footings not supported on piling shall be inspected and approved by the Bridge Engineer or his authorized representative previous to placing any concrete. All foundations must be inspected by an Engineer of the Bureau of Public Roads unless such inspection is specifically waived. In order to avoid delay to the Contractor, the Bridge Department should be advised through the Division Office in advance of the expected date of reaching footing grade, and then advised when the excavation is completed and inspection is desired.

Request for inspection must include information as to material encountered and depth penetrated. In case the field engineer considers the foundation material

unsuitable for the design footing pressures, he shall so advise, otherwise it will be assumed that the field engineer is of the opinion that the foundation materials are satisfactory.

In case of emergency, or if even a short delay would inconvenience the contractor, the Bridge Department may be notified direct, a copy of the notification being sent to the Division Office.

6.33 Approaches On approaches which are a part of the bridge project, the requirement that a definite number of road graders shall be used in road mix work was designed for large jobs and does not apply in the department.

6.34 Salvage **Creosoted Timber Pile Cut-offs**—All cut-offs six feet in length or over, where the piling is paid for on a linear foot basis, shall be saved for the use of the Maintenance forces. When pile cut-offs of this length are available, the Division Office should be notified in order that they can be picked up by the Maintenance forces.

Old Structures—When we take over and replace an old county bridge, the materials in the old structure which were placed by the County remain the property of the County. Any materials in the form of repairs or improvements which have been placed in the old structure by the State remain the property of the State.

Bridge materials which are to remain the property of the County should be removed carefully and the County Commissioners notified that the materials are subject to their disposal. Care should be taken by our engineers to prevent unauthorized persons removing materials from a project. No materials should be allowed to be removed from any project, if these materals are the property of the County, without a written order from the County Commissioners.

6.35 Laboratory Control All materials must be tested or inspected and approved by the Laboratory, or its designated representative, previous to their use in Bridge construction. Two copies of Form 15, listing the required samples for each project, are mailed to the Division Engineer shortly after the contract is awarded.

6.351 Liquids and Semi-Solids

M. S. H. C. Specifications require that representative quantities of materials (such as Paints, Creosotes, Tars and Asphalts) shall be submitted to the Laboratory for examination and test.

A poorly taken sample wastes a great deal of time and money.

Good analyses of poor samples are worthless.

Much delay is caused when it becomes necessary to resample and retest.

Skill and previous experience are of great value to the engineers actually engaged in, or supervising the sampling. These directions point out only some of the main features in sampling.

Samples shall, if possible, be taken at the time of RECEIPT of the shipment. Good samples of creosotes, tars, and asphalts cannot be secured after prolonged heating. Nor can good paint samples be secured after the paint has been partially dried, settled, thinned, etc.

Precautions shall be taken to assure that the sampling apparatus, such as dippers, funnels, etc., and the samples themselves are not contaminated nor altered with dirt or any other extraneous matter.

Sample containers must be very clean and thoroughly dry before filling, and shall be of such types as will protect the sample from contamination or deterioration. Sample containers shall be very tightly closed immediately after collection.

Tin cans with screw caps are preferable for paints, creosotes and soft tars or soft asphalts, but only when the inside is known to be free from dirt, water, gasoline, corrosion, pin-holes, etc. Wide-mouth friction-top cans are preferable for hard tars and hard asphalts. Clean bottles of proper size are acceptable if well stoppered with clean corks free from holes, or sealed with tight-fitting screw caps.

Sample containers must not be filled so full that there is no room for expansion due to changes in temperatures.

6.352 Paint and Creosote

Paint should be sampled by vigorous and thorough stirring of the contents of the container. This should be followed by pouring the paint from the container into another empty clean container, back and forth several times. A one pint sample can should be filled about nine-tenths full immediately as paint starts

to settle as soon as agitation ceases. A large volume of air over sample starts drying action that changes the sample.

Creosote should be sampled much like paint. Stir and shake (if container is not too large) until all parts are thoroughly mixed to give a good average sample, the object being to obtain a sample that will be representative of the water content as well as any crystalline form of creosote which may exist at certain lower temperatures. A one quart sample of creosote is sufficient.

6.353 Tar and Asphalt If the tar or asphalt flows at ordinary temperatures a sample may be taken by dipping out portions from the well stirred container. If the tar or asphalt is semi-solid or brittle, a sample should be taken by cutting or chipping off several small chunks from all portions of the material, forming a composite of at least a pound. Samples of this harder type of material should be placed in a wide-mouth tin or jar. Neither the original materials nor the sample should be melted while collecting the sample. Borings samples: samples obtained by collecting the chips made by boring holes with a ship auger from top to bottom of the material contained in a barrel, case or cake, may be submitted for hard tars and hard asphalts. A quart of liquid tar or liquid asphalt constitutes a sample. A pint or pound of hard tar or hard asphalt is usually sufficient.

6.354 Identification and Shipment As soon as the sample containers are filled and tightly closed, they must be properly marked for identification. This may best be done by securely fastening a tag to the container, though gummed labels pasted around the container are acceptable. This tag or label should contain practically the same information as written on the mimeographed sheet enclosed with the sample (see below). These tags or labels shall be permanently marked (preferably with a pencil hard enough to dent the paper—soft pencil and ink markings are liable to obliteration from moisture, handling, or smearing with material). A sample from each grade of each company represented shall be submitted.

One mimeographed Sample Report Form shall be filled out in duplicate (good carbon copies are accept-

able) for each sample submitted. The following information shall be included:

1. Name of Material
2. Grade of Material and Trade Name
3. Manufacturer of Material
4. Quantity of Material
5. Project Number
6. Name of Sampler
7. Date of Sampling
8. Copy of any analysis or other special information on the original containers.

The carbon copy of the Sample Report Form is enclosed with the sample. The original is mailed in to the Helena Laboratory.

All samples, especially those in glass, whether shipped by mail, express or messenger, shall be well packed to avoid spillage, leakage, breakage and loss by evaporation or alteration while in transit.

Samples of these materials are generally classed as inflammable and should be so marked when expressed. Inflammable materials are not allowed in the mails.

6.355 Sand and Gravel

The sampler should realize that few, if any, natural sand and gravel deposits are uniform and when a sample is taken the quantity of material in the deposit similar to the sample shall be ascertained as nearly as possible. If the deposit presents an open face, the sample shall be taken by channeling the face so as to present material that visual inspection indicates could be used. Care should be taken to eliminate any over-burden or stripping at the top or any that has fallen along the face of the top. It is necessary, especially in small deposits, to excavate sufficient test pits to prove the deposit. Deposits which present no open face must be proven and sampled by means of test pits.

It is particularly difficult to obtain representative samples of sized sand and gravel in bins or stockpiles. Whenever possible, sand samples shall be taken in a moist condition. Stock pile samples shall be made up of several small samples taken from various points, care being taken to avoid sections which appear to have been subject to segregation. Bin samples may be taken at either the loading or discharge chute.

Mixed aggregate samples shall consist of at least 40 pounds. The larger the maximum size, the larger

the sample required. Sand samples shall consist of at least 10 pounds. Coarse aggregate samples shall consist of at least 30 pounds.

All aggregate samples must be accompanied by a completely filled copy of Lab. Form No. 1, the original of which shall be mailed to the Testing Laboratory.

6.356 Galvanized Hardware A representative sample shall be submitted for each lot of hardware of a particular type. The average timber jobs will require the following samples: 1 bolt with nut, 1 cut washer, 1 cast or cast malleable washer, several galvanized nails, sample of drain metal and screen and sample of pipe cap metal.

Each sample shall be accompanied by full and complete information, as to name of manufacturer, date sampled, quantity and name of material and name of sampler.

6.357 Reinforcing Steel When reinforcing steel is required for bridge work, the amount is invariably great enough to not only justify, but to necessitate plant inspection. After a bridge contract has been awarded, the Testing Laboratory ascertains the source of the reinforcing steel and arranges for plant tests and inspection by a commercial laboratory. The field engineer is notified of this action, and, when the material reaches the project, that official can readily determine whether or not the reinforcing steel has actually been inspected, as all commercial laboratories attach inspection tags to several of the bars. After inspection has been arranged, it is seldom that a shipment is made without inspection actually being made.

Where a small amount of reinforcing steel is required, such as may be purchased at local hardware stores, for instance, the field engineer should submit one sample of each size bar to the Testing Laboratory. Test specimens should be from eighteen to twenty-four inches in length, and when submitting samples the engineer should advise the name of the manufacturer, name of dealer and amount of each size represented.

The fact that any shipment of reinforcing steel has been inspected at its source does not prevent its rejection on the project for any valid reason.

6.3571 Structural Steel

In all cases where structural steel is required for bridge construction, except on ice-breakers for treated timber pile trestle bridges, the Testing Laboratory arranges for mill and shop inspection by a commercial laboratory. The field engineer is notified when such inspection has been arranged. In cases where ice-breakers are placed on treated timber pile trestle bridges, the field engineer should make a visual inspection and report by memorandum to the Testing Laboratory.

The fact that any shipment of structural steel has been inspected at its source does not prevent its rejection on the project for any valid reason.

6.358 Lumber and Piling

Treated Piling. When a contractor places an order for treated piling, the Testing Laboratory arranges for inspection of the material both for grading and treatment, the field engineer being advised when such arrangements have been made. Currently, we are using the Robert W. Hunt Company for this purpose. That company places an "H" with a shield hammer at the end of each pile inspected and accepted.

Untreated Piling. Whenever possible, the the Testing Laboratory arranges for grading inspection on untreated piling, the field engineer being advised when such arrangements are made. In a number of cases, untreated piling is purchased locally where no facilities exist for commercial inspection. In such cases, the field engineer is to inspect the untreated piling in the field, reporting to the Testing Laboratory the result of such inspection.

Treated Lumber. The testing Laboratory always arranges for the inspection of the treatment of treated lumber, the field engineer being advised when such arrangements have been made. Currently we are using the Robert W. Hunt Company for this purpose. That company places an "H" with a shield hammer at the end of each accepted piece, with the exception of 2x4's. This "H", in the case of treated lumber, indicates the Hunt Company has inspected for treatment only. We require the furnishing company to furnish us with proper grading certificates covering the grading of the lumber. After these certificates have been reviewed, the field engineer is advised whether or not the material that reaches the project is of an acceptable grade.

Untreated Lumber. We require the furnishing company to furnish us with proper certificates covering the grading of untreated lumber. After these certificates have been reviewed, the field engineer is advised whether or not the material that reaches the project is of an acceptable grade. In a number of cases, contractors do not purchase untreated lumber from the same source as treated lumber is secured. In such cases, when the securing of grading certificates is not possible, the field engineer will make inspection of the untreated lumber, and will report the results of such inspection to the Testing Laboratory.

The fact that any shipment of lumber or piling has been inspected at its source does not prevent its rejection on the project for any valid reason.

6.359 Concrete Cylinders **Method of making and storing compression specimens of concrete in the field.**

Molds used will be furnished by the Testing Laboratory, 6″x12″ cylindrical form. The base and cap plates shall have a plane, non-absorbent surface and shall be two to three inches larger in diameter than the mold.

Concrete for the test specimens shall be taken immediately after it has been placed in the work. All concrete for a sample shall be taken from one place. A sufficient number of samples shall be taken at different points so that there will be a fair average of the concrete placed in that portion of the structure selected for tests. The location of each sample shall be noted for future reference.

Samples shall be taken from the mass by a shovel or similar implement and placed in a large pail or other watertight receptacle and immediately transported to the place of molding. Different samples shall not be mixed together, but each sample shall make one cylinder and shall represent the total mixture of concrete from a given place.

When sample is taken to a place of molding, it shall be dumped into a non-absorbent, watertight receptacle and, after slight mixing to offset possible segregation, immediately placed in mold.

The specimen shall be molded by placing the concrete in three layers four inches thick. Each layer shall be puddled with twenty-five strokes of a bullet-pointed

metal rod, 5/8"x24" in length. The strokes shall be distributed in a uniform manner over the cross section of the mold and shall penetrate into the underlying layer. After puddling the top layer, the excess concrete shall be struck off with a trowel and the specimen covered with the cap plate.

Two to four hours after molding, the test specimens shall be capped with a thin layer of stiff neat cement paste in order that the cylinder may present a smooth end for testing. The cap plate shall be worked on the fresh cement paste until it rests on top of the mold. The cement paste shall be mixed two to four hours before it is to be used in order to avoid shrinkage of the cap. The cap and base plates may be oiled to prevent adhesion, or a paraffined paper may be inserted.

Cylinders shall not be moved or be removed from the molds before the age of twenty-four hours and shall be immediately buried in damp sand. In case paraffined paper molds are used, the molds shall be left on until just previous to the compression test.

The test specimens shall remain buried in damp sand until ten days prior to twenty-eight day tests. They shall then be packed in damp sand or wet shavings and shipped to Professor L. D. Conkling, Montana State College, Bozeman, Montana, where they will be placed in damp sand until date of test. The shipper shall fill out laboratory Form No. 4 for this purpose in quadruplicate, one to accompany test specimens, one copy to be mailed to Professor L. D. Conkling at Montana State College, Bozeman, Montana, one to be mailed to the Highway Testing Laboratory at Helena, Montana, and one copy to be mailed to the Highway Bridge Department at Helena, Montana.

Care should be taken that the specimens be protected from drying after removal from damp storage and before testing.

6.36 Completion The sequence of operations incident to completion is similar to that outlined in Paragraph 1.36 of the Construction section of this Manual.

6.37 Submission of Notes All notes showing ground line and footing elevations, pile penetration, etc., must be entered in the "Structures" notebook and properly indexed

for submission with the final estimate. Incidental computations for quantities must be in a form to facilitate easy checking in the Headquarters Office.

6.38 Plans as Built When changes in plans have been made during construction, black and white plans will be provided upon which the changes will be noted in red ink. Three sets will be prepared, one for the Division Engineer and two for transmittal to the Headquarters Office. No "Plans as Built" need be submitted when the project contains all timber structures.

CHAPTER VII

PRE-CONSTRUCTION DEPARTMENT

ORGANIZATION AND GENERAL DETAILS

7.1 Organization

7.11 Headquarters Office The Pre-Construction Department is charged with the responsibility for the location, design and procurement of Right of Way preparatory to the award of contracts. The work is interlocked with that of the Construction Department in that this section of the whole organization furnishes the source or basis for all subsequent operations. The State Highway Engineer is represented in the Department by the Pre-Construction Engineer.

7.12 Division Offices The field location, subject to the advice and direction of the Pre-Construction Engineer, is in charge of the Division Engineers and their offices will serve as the channel for all communications, both to and from the field. Resident Engineers, Project Engineers, and Locating Engineers when assigned, will be directed by the Division Engineers in all field location work.

7.13 Pre-Construction Engineer On the recommendations and request of the Commission through the State Highway Engineer, the Pre-Construction Engineer will make the route surveys and assign controls for all subsequent location work. The location being complete he will assign technical controls in the preparation of the design and then prepare data, according to the limits of each allotment, to serve as a basis for bidding. The Pre-Construction Engineer is charged also with the administration of all business pertaining to the procurement of Right of Way for all highways as they are proposed for construction. Authority as needed for the consummation of the field work is delegated through the office of the Division Engineer.

7.14 Right of Way Engineer The Right of Way Engineer is in charge of the technical details and legal work in the Right of Way Department. He will be responsible for

the preparation of all descriptions, the expenditure of funds to procure necessary Rights of Way and the legal prosecution entailed in condemnation suits, etc. All communications and orders to the field will be directed thereto on the authority and permission of the Pre-Construction Engineer.

7.15 Plans Engineer The Plans Engineer is in direct charge of the design on all road projects, subject to the advice and direction of the Pre-Construction Engineer and the Bituminous Department in matters relating to road oiling.

7.16 Office Engineer On completion of the design the Office Engineer will summarize all quantities thereon and using the estimated prices given by the Pre-Construction Engineer will prepare all requisite data for the award of contracts. If any special details exist, not covered by the Standard Specifications, the Office Engineer will prepare special provisions to serve as a control in the construction work.

7.17 Division Engineer The Division Engineer will regulate all field location work both in the survey and the preparation of the field maps. He will combine his knowledge of the survey area with that of the locator in all matters relating to the design which warrant special attention. His recommendations as to the design will be entered in the letter of transmittal (in duplicate) for consideration by the Pre-Construction Engineer and the Plans Engineer.

7.18 Resident Engineer Resident Engineers, when assigned to location work, will be charged with furnishing an accurate and complete field basis for the design. All notes and other data will be forwarded through the Division Office for consideration and transmittal to Helena.

7.19 Project Engineers and Locating Engineers Project Engineers and Locating Engineers being of similar capacities will be placed in immediate control of the location survey. Upon them devolves the first responsibility for satisfactory location work. All reports, communications, etc., will be delivered through the offices of the Division Engineers.

7.20 Inst. Men, Rod Men, Etc. Under the direction of the chief of party, the instrument men, rodmen, chainman, etc., will secure the detailed data necessary in the design.

7.2 General Details

7.21 Referral Much of the work in location should be carried on according to the directions given heretofore in that section of the Manual treating with the Construction Department and the locator is referred thereto for compliance, particularly in regards to care of instruments and the submission of reports. Specific paragraphs and topics are as follows:

Addresses, Laws, Relations with Public, Relations with Other Departments, Instruments, Expendable Equipment, Mobile Equipment, Requisitions, Accidents, and Correspondence.

7.22 Route Surveys The first step in the location and construction of highways is initiated by the Highway Commission in that they will request a routing between two stated termini. The request will be transmitted through the State Highway Engineer to the Pre-Construction Engineer and he will negotiate with the Bureau of Public Roads to establish the routing. A route survey will then be instituted in which the probable location will be fixed through the area selected for routing. The survey is not exact or precise, but the conclusions drawn from the perusal of existing topography will govern the final location.

The routing will be made by the Pre-Construction Engineer working in cooperation with a representative of the Bureau of Public Roads and, if possible, the Division Engineer. The routing will be established on the comparative bases of economy and utility; for example, one side of a valley would be chosen in preference to another, because of better exposure and resultant year round use. Alternate routings will be considered and compared as to length and probable cost of construction. The report on completion of the route survey will constitute a thorough description of the elements entering into the selection of the route to be located. Salient features embodied in the report are as follows:

1. Distance or length between stated termini.
2. General alignment.
3. Special hazard due to sharp curves, etc.
4. General grade features; frequency of use of maximum ruling or allowable grade, etc.
5. General drainage conditions.
6. Foundation soil or supporting ground.
7. Availability of suitable deposits of construction material.
8. Snow conditions.
9. Railway grade crossings; cost of elimination.
10. Possibility of use or abandonment of existing and usable improvements with details.
11. Major stream crossings.
12. Expense of right-of-way.
13. Local traffic service; accessability to shipping points, industries, etc.
14. Through traffic service.
15. Present development of tributary land.
16. Possibility of future development of tributary land.
17. Scenic value.
18. Conditions affecting maintenance of the improved highway.

In developing the facts upon which a recommendation is to be submitted, consideration should be given to local opinion, particularly the local highway officials, the older residents and the proprietors of business enterprises.

In case it is proposed to change existing alignment to eliminate railroad grade crossings, the Railway Company should be represented in the routing party by a responsible person. Similarly, if possible damage to utility companies or to major irrigation systems is occasioned, responsible parties should be invited to accompany the party.

On completion of the routing the report will be filed with the State Highway Engineer for his findings and recommendation. The route map will then be prepared from the data comprising the route survey report for submission to the Bureau.

7.221 Reconnaisance The route survey and report thereof, will in most instances serve as a reconnaisance survey. In general the controls established in the route survey are binding

as to the area to be traversed. If a reconnaisance survey is in order it is usually required to locate the direction of the line over some difficult interval constituting a part of the whole routing. The recoonnaisance survey is further distinguished from the route survey by the fact that the controls are established or confined in a smaller area by the use of instruments, usually a Brunton transit or prismatic compass, aneroid barometer,, and clinometer or slope level.

The reports and findings on the reconnaisance will be amplified and extended to fix tentatively the controls set forth in the route survey.

7.222 Work Orders When the routing is approved by the Bureau, work order numbers are assigned by the Accounting Department authorizing the survey of the routing or any part of the routing. These numbers will be transmitted through the Division Office to the locator; any notice that the number has been changed or that the routing has been assigned a project number will be conveyed to the Field Engineer through the regular channels.

7.23 Preliminary Inspection On notice of the work order and assignment to the location the Locating Engineer in company with the Division Engineer will go over the routing and discuss the survey with respect to the controls established on the route survey.

7.231 Equipment and Supplies Normal equipment of the field party would consist of a transit, engineer's level, hand level, two 100-foot steel tapes, two range poles, two level rods, clinometer, two hand levels, two 50-foot metallic tapes, axes and plumb bobs. The field draftsman would be supplied with a drafting table, drafting office equipment and a 30-inch steel straight edge. The size of the party would govern as to the equipment required on the location. The care and usage of equipment and instruments is given in Paragraph 1.30 to Paragraph 1.31.

As a part of the equipment for referral and use, the locator should have a Solar Ephemeris, U. S. G. S. level data, Forest Service maps or other maps to show the section lines, rivers, etc., Harger and Bonney High-

way Engineer's hand book and "Plans as Built" for projects in the vicinity.

Other supplies furnished on requisition and necessary in the prosecution of the work are as follows:

a. Hardshell drawing paper, 21 inches wide.
b. Hardshell profile paper, 10 inches wide.
c. Co-ordinate sheets, Form No. 16A.
d. Memo pads, Form No. 4.
e. Correspondence Books, Form No. 7.
f. Scratch tablets, inventory sheets, etc., according to the demands of the office routine in the several divisions.

7.232 Personnel The locator is charged with responsibility for economical operation in the field survey. The personnel assigned to location is drawn largely from the Construction Department, thus keeping experienced men in reserve for future work.

As a consequence the size of the location party fluctuates according to activities outside the scope of the Pre-Construction Department and the locator is faced with the problem of administering the survey with parties of varying size. The minimum limit for economical operation is four in the party, not counting the locator. The field drafting would then be done by the members of the party when time is afforded. The party should then be increased in increments of three to take care of the levels and cross sections, the topography and the land ties respectively. A field draftsman should be provided when the size of the party numbers seven.

A party of four, the instrument man, two rodmen, usually, and the axeman would be supervised by the Project Engineer or Locating Engineer acting as the Chief of the Party. This party would do all work incident to the survey. As the personnel is increased certain other capacities would be added to the roster according to the various classes of work.

7.24 Correspondence All correspondence shall be directed through the office of the Division Engineer or referred thereto. Insofar as is possible, the letter shall refer to a single subject and proper headings will be written to identify the letter by the work order or project number and the

name of the proposed highway. Carbon copies of all communications should be on file with the locator.

7.241 Basic Reports Weekly letters will be written and submitted to the Division Office according to the directions insofar as applicable, in Paragraph 1.411.

7.242 Survey Progress Reports Survey Progress Report (Form No. 110) will be prepared and submitted at the conclusion of the working week. The original and duplicate will be submitted to the Division Office for transmittal to Helena.

7.243 Inventories The locator will be called upon to submit inventories as per the directions in Paragraph 1.412.

7.244 Engineering Payrolls See directions in Paragraph 1.415 for approved procedure.

7.245 Transfers See directions in Paragraph 1.416.

7.246 Notice of Receipt See directions in Paragraph 1.417.

7.247 Samples Refer to Paragraph 1.418 for general directions in addition to those given hereafter in Paragraph 7.9-7.96.

7.25 Payrolls Payrolls Form No. 31 will be submitted in the form recommended for compliance in the Construction section of the Manual.

7.251 Location Expense Allowance A flat rate of $30.00 monthly is allowed as a location expense allowance when away from the base designated as Headquarters and will be entered on the payroll as a separate item for each employee. The sequence of operations then, in making up a pre-construction payroll, would be to show the employee's name (allow two spaces) and then distribute the salary according to projects. An additional two spaces would then be allotted immediately under the payroll distribution to show the location expense allowance.

If assigned to location work of extremely short dura-

tion, the party will be allowed expenses in full as stipulated in Paragraph 1.44 of the Construction section of the Manual.

7.26 Relations with Public The Highway Commission has a very commendable record in the matter of road building and it is desirable also that the members of the organization will be accepted in the various communities as valuable and dependable citizens. It remains for the location party to prepare the way for those who will come on the work at a later date. Personal conduct should be above reproach and any dealings with the public should be direct and pointedly courteous.

7.261 Public Interest The public will be interested in the probable alignment and in many cases will recommend certain alternates for study and consideration and the locator should not act decisively on the suggestions, but rather refer them to the Division Engineer, citing the source and any other pertinent data. Many suggestions are motivated by personal interest and the locator should, if such is the case, advise the Division Engineer.

7.262 Trespass Insofar as is possible, do not enter upon cultivated and improved land except by permission from the owner. Advance the reasons for entering upon the land and describe the extent of the encroachment, but do not discuss Right of Way values or the attitude of the Commission as regards Right of Way payments.

7.263 Right of Way Considerations It is to be emphasized that the locator should not discuss any of the features of the location to inconvenience the later Right of Way negotiations. This remains for the Right of Way Department and all discussion or comment should be referred thereto through the Division Office.

7.27 Photographs Kodak pictures, taken on location are of value to the Plans Department. Note on the back of the picture the station from which taken and the direction. Pictures are of exceptional value not only in difficul terrain, but on uniform prairie location; one or two pictures showing typical topography are of great help to the office in visualizing field conditions. Another help is

to show the center line in black ink on the film so that it will appear as a white line on the print.

7.3 Alignment

7.31 Alignment Controls The controls established on the reconnaisance survey are not set for rigid compliance. The responsibility for ultimate perfection of alignment devolves upon the locator. The reconnaisance is essentially a general survey of an area; the location is a survey of a fixed line within that area. To fix the line then, the engineer will compensate the controls given on the reconnaisance, to best suit the area. Due consideration should be given to the fact that the road proposed is a public improvement and therefore should be located to accommodate local traffic as well as the traffic of the public at large. The shortest distance between two points would be considered the best alignment, provided the drainage facilities and gradients are reasonable. The cost of Right of Way and the probable damage to property owners would also figure as important elements in the choice of the alignment. Ordinary controls to fix the alignment will follow hereafter.

7.311 Main Routes

7.3111 Right of Way Considerations Assuming that the alignment had been routed along an existing county road and knowing that the minimum R/W now designed is one hundred feet, the line would be fixed in a location to get the benefit of the compacted roadway in whole or in part, and the new R/W required should be designated to come from the side of the road which has the lesser real value. In this connection, it is to be remembered that the line need not be located exactly in the center of the proposed R/W tract, the minimum limit being 30 feet on any one side.

Damages to property owners should be minimized, but not to the detriment of the alignment. If the alignment traverses a cultivated field, justify its presence there with continued good alignment. The road should be located to afford the most public good for the least private damage.

7.3112 Poles Pole lines in many instances will furnish a convenient basis for lining out the roadway. Do not cause any unnecessary movement of poles to accommodate the survey.

7.3113 Irrigation Systems Irrigation systems constitute a probable source of dispute during the life of the improvement, this is especially true if the ditches have to be rebuilt to accommodate the roadway; where possible, avoid them. Do not closely parallel a ditch for any protracted length.

7.3114 Snow Conditions Every effort should be made to avoid bad snow conditions. This generally means to avoid north exposure. Check with the local residents as to the prevailing winds and also the snowfall in the area.

7.3115 Ruling Grade In general the ruling maximum grade in the State is 6%. This, of course, constitutes a control in staking the alignment in mountainous terrain.

7.3116 Streams Where streams or rivers are encountered, ascertain the high water level and stay above it. The alignment then would be governed by the high water contour. If a crossing is necessitated, stake the alignment normal to the stream flow if possible.

7.3117 Railroads Parallel railroads exactly if in the immediate vicinity.

7.3118 Soil Conditions The soil conditions will govern in the selection of the route. If through bottom land, ascertain the elevation of the ground water, in any case judge the foundation on a basis of stability.

7.3119 Curvature Do not use "broken backed" curves. The exception to this rule would be in a case where the ruling grade would control the direction of the line and the cost of eliminating the curve would be prohibitive. A "broken back" curve is simply two curves in the same direction joined by a short tangent. The line is objectionable from an engineering standpoint because it does not present symmetry; as the name implies, the line looks broken. In most cases the situation can be remedied by extending the two outside tangents to an intersection and then substituting one long curve for the two curves.

Other limits of curvature are as follows:

a. Maximum curvature, 15° along the length of the survey, the radii will of necessity be decreased to not less than 100 feet for the legs of the wye at the junction with another route.

b. The tangent between reverse curves shall not be less than 150 feet. The ideal connection between reverse curves would be the length equivalent to the standard run-off distance for both curves.

c. Where feasible, locate curves on the tops of hills, but in so doing, allow sight distance to the length shown in the Standards by inserting long vertical curves in the grade.

d. Avoid locating curves at the bottom of a long grade tangent.

e. Harger and Bonney tables will be used in all curve computations.

7.312 Secondary Roads Economy is the watchword on all secondary roads. The controls are generally as given heretofore; however, probable Right of Way costs would be considered of more importance in the selection of the line than in the main traveled routes.

7.313 Urban Routes Follow the line as shown in the municipal plats. The authentic plat is always recorded in the office of the County Clerk and Recorder.

7.32 Meridian All surveys shall be oriented with respect to the true meridian. Solar observations are satisfactory and the method of taking the observation and computing the azimuth as shown in Harger and Bonney's Highway Engineers' Handbook is recommended for field use. All subsequent courses will be calculated with reference to the meridian established by the observation. The observations will be repeated at intervals of six to ten miles or at the terminal points of the survey.

Solar Ephemeris Tables are available on requisition through the Division Office.

7.321 Direction All location surveys will be made from west to east or from south to north. If the project is being located preparatory to re-construction the courses established

on the original location survey will govern. These bearings and the curve data will be procured from the "Plans as Built". Similarly all surveys for bridge structures, particularly railroad grade separations, should be located according to bearings given on the "Plans as Built."

The calculated meridian and subsequent courses will be checked roughly by recording the magnetic bearing for each tangent. The magnetic bearing will be shown in the notes according to the form specified in the Standards.

All notes and computations pertaining to the observations shall be entered in the "Transit Notes."

7.33 Preliminary Line The preliminary survey will be identified as the "P" line. Any changes or alternate lines will be identified as "P-1," "P-2," etc. in order of their sequence.

Insofar as is possible the engineer should, with the data given in the reconnaisance report, locate the line as it will be built. If a preliminary line is necessary, locate it and record the topography as directed by the Division Engineer. In an area, usually heavily wooded or in which a ruling grade will control it is necessary to run in a preliminary line. If the preliminary line is worked on a ruling grade, the line should be established from the top of the hill down, and, depending on the topography, the vertical angle set off on the instrument should be set to establish a grade from one-half per cent to one per cent less than the ruling maximum grade. In extending a located line by use of a preliminary line the engineer should extend the located stationing likewise, for example, if the line were located to the bottom of a hill, the preliminary would be started at the top and traced back to connect with the located line. However, in tracing the line down hill only the angle points would be set. After the connection had been made, the line would be chained and staked to produce the location stationing ahead. A preliminary line is essentially a base line; the designers project for the final location on the presumption that the survey is an accurate and true picture of the area, hence it is very important that a high degree of accuracy, both in the instrument work and the chaining, be maintained. All angles should be doubled and all

chaining should be from point to point on the stakes, and where the slope warrants, plumb bobs should be used.

All breaks in the profile should be staked or as many breaks staked as will be convenient for the level party. The level party should not have to measure out breaks for profile readings. If stakes are placed at a minimum twenty-five feet intervals any intervening break in the profile could be measured in with a rod. Other features of topography, such as fence crossings, ditch crossings, etc., should be staked at the time the preliminary survey is made for later convenience in making the land ties and recording the topography.

7.34 Located Line When in the course of the survey it becomes apparent that the line can be fixed in its probable final location, the engineer should make provisions to perpetuate the line for the convenience of the Construction Department. P. I's. and intervening P. O. T's. should be referenced, not as often as needed for construction, but enough so that all tangents can be re-established with accuracy. As in the preliminary survey, stake all profile breaks, fence crossings, irrigation crossings and stream crossings. In chaining, check from point to point on the station stakes.

7.341 Tangents In fixing the tangents, the instrument man should use a foresight rather than a backsight.

7.342 Curves Curves of any great length should be staked, using the center of the curves as a control. This point can be fixed by measuring and setting the middle of the curve from the P. I., the computed external being the distance to chain and the angle to deflect from the back tangent is equivalent to 90° plus one-half of the central angle. In using this control, any errors in chaining the semi-tangents or measuring the central angle will be apparent before the whole curve is staked. Do not stake curves from tangent offsets.

As a means to save time in the field work all curves should be run in with the instrument at the P. T. providing of course that the P. C. is visible therefrom.

7.343 Equations Equations are to be avoided; if encountered the adjustment in stationing will be carried ahead to the P. T.

of the succeeding curve. The equation should be shown plainly both in the field and in the notes to prevent any oversight.

7.344 Staking In staking the line, the marking should face toward the beginning of the project. The stakes, ordinarily 1" 2"x18", should be set to a depth of at least nine inches. Where the transit line follows a traveled road the centerline will be located by using wooden "plugs;" these can be made up from the stakes. In offsetting from this line, set the stake clear of traffic and any future maintenance operations. To expedite the cross-sectioning work, it has been found practical to place the offset stakes at or near any topographic features, such as fence lines, poles, irrigation structures, etc.

As stated before, much of the survey work is relocation along roads previously built and oiled; in this event "plugs" would be inserted and the stationing painted on the roadway. Offset stakes in this case should be set out at every tenth station and at the P. C's., P. T's. and P. O. T's. The stationing would be painted on concrete paving also and indicated exactly by chisel marks.

7.35 Ties

7.351 Land Ties Land ties are necessary at any point at which the survey crosses a section line or subdivision line. Under ideal conditions, the land line should be established from corners on each side of the survey line. The intersection angle and stationing then being recorded and the distance to either one of the corners being measured and noted. The corners used in making the ties would then be marked in the notebook as "found." On many surveys it is not now possible to establish an ideal intersection with the land line as described above; in this event, the engineer should re-establish lost or obliterated corners by methods approved by the U. S. Land Office. The method of extending the line and a description of the corners found, should be recorded. Existing fence lines constitute in many cases, a division in ownership and ties should be made thereto with the same exactitude as for ties to section lines.

Whenever a land line intersects the survey on a curve, the tie should be made at the curve intersection

and the angle should be deflected from the tangent at that point. The method of recording the tie, either on a tangent or on a curve is illustrated in the Standards.

7.352 Municipal Ties All intersections at city limits lines should be tied and recorded in the notes. Ordinarily the bounds of a municipality are accurately described and well referenced. However, in the event that the corner markers are destroyed, existing fence lines, if any, should be tied in. The method of making the tie would be similar to that described in making a land tie.

Ties within the city limits are made to prove the survey; assuming the city was laid out accurately the chaining and measurement of angles on the survey should check exactly with the plat of the city. All property lines shall be extended to intersect with the centerline and ties made thereto. Property lines are not generally marked precisely; however, if the width of the street is known the property line could be established either from the center of the street or from the curb lines.

In many cities, the centers of the streets are accurately referenced with iron pins or stones, usually about 12 inches under the surface. The survey should be traced on the lines established by these corners and the chained stationing between them would then constitute a tie.

Common practice in tying city limits lines and property lines is illustrated in the Standards.

7.353 Mining Claims All mining claims and placers should be tied very accurately and definitely to the centerline. Plats are available, usually at the office of the County Clerk and Recorder showing the corners as originally set and also the witness corners. If in the near proximity of the claim, the claim lines should be extended to an intersection with the centerline and tie made thereto.

7.354 Railroad Ties When in the near vicinity of a railroad, accurate ties are necessary. The following directions are set forth for strict compliance:

a. Two ties shall be made to each railroad tangent.

These ties are to show the angles and the distances along the tie lines between the centerline of the highway and the centerline of the railroad. From the intersection of the tie line on the railroad, the engineer shall measure to some permanent structure thereon, noting the railway station and number of the structure. From this tie, the Right of Way Department will then be able to describe the encroachment accurately. If there is no encroachment the tie will still serve as a means of describing the topographic features in the vicinity of the survey.

b. In tying in a section line, at or near where the Right of Way will encroach upon that of the railroad's, tie the section line into the centerline of the railroad, note the angle of intersection and the distance between the railroad centerline and the highway centerline. Measure from the point of intersection to some structure along the railroad and record its railway stationing or number.

c. Tie all switch points and sidings to the survey centerline.

d. When tying to steel bridges, tie in the inside face of each parapet wall and give the distance between them. On concrete slab bridges tie to the end of the slab giving the length of the structure from out to out of the slab.

e. Mile posts, small wooden structures, and block signal masts are not accurately stationed on the railroad maps; consequently ties should not be based on any measurements thereto.

7.3541 General When making ties, utilize the "set-up" to record all topographic detail within the range of the tie, for example, when chaining along a section tie note and record any stream crossings, houses, farm buildings, road crossings, fences, etc. In many cases these features can be connected with the detail topography taken at the centerline.

7.3542 Notes All notes pertaining to the meridian observation and the alignment will be recorded in the "Transit Notes." The Standards, Plate No. 1, illustrates the form to follow in recording the curve data and the reference points. Land ties and ties of similar nature should be recorded in the "Topography" notes.

7.4 Levels and Cross-Sections

7.41 Level Datum All levels are to be referred on the U. S. G. S. datum and the engineer should have the elevations of bench marks shown in "Spirit Leveling in Montana," publication by the U. S. G. S. Where the U. S. G. S. bench marks are not available, railroad or U. S. R. S. datum should be used. The highway program is now advanced to the stage where correct datum usually is available from adjoining projects.

7.411 Bench Marks The size and disposition of the party will govern as to the methods used in running the levels. In any event, whether the benches are set prior to the cross-section work or during the time the cross-sections are taken, they are to be set as a permanent or near permanent feature of the survey. Benches will be set at the beginning and end of the survey and at intervals of approximately 1000 feet and at probable bridge sites. The bench marks will consist preferably of heavy nails driven in poles or trees; permanent large rocks that are easily distinguishable, and any permanent structure which will not be disturbed during construction work. Hubs with guard stakes are not satisfactory as bench marks; if the topography will not allow bench marks to be set according to directions herebefore, use iron pins. In setting the benches locate them to preclude any possibility of being destroyed or disturbed. In tying the bench to the centerline, measure the offset accurately so that it can be found easily according to the directions in the recorded description.

7.412 Turning Points Turning points should be considered an integral part of the level datum and so described in the notes.

7.413 Limits The allowable error in levels should not exceed one-tenth of the square root of the number of miles run.

7.414 Check Levels All levels should be checked. A closure between two U. S. G. S. benches would constitute a check in the levels. It sometimes happens that in the disposition of the party at the beginning of the survey, it is advantageous to assign two men to running bench levels ahead of the transit line. In this event the levels run during the cross-sectioning work, serve as a line of check

levels also. If check levels are run as the last feature of the work, the limits of closure would be as given above.

7.415 Profile Levels It is preferred that the profile levels be taken with the cross-sections. If levels are run over the line for profile elevations, lath or stakes should be placed at all points where rod readings are taken so that the cross-section party will not err in their work.

7.416 Cross Sections Cross-sectioning should be combined somewhat with the work of taking and recording topography. The designers are very desirous of having accurate ties to irrigation ditches and other features which would have a bearing on the final grade. If the line follows an existing road, show the shoulders thereof according to the legend prescribed in the Standards.

In taking elevations on an irrigation ditch for example, the tie is valueless to the designers unless both the elevations and the distance out is given, and the time to accurately ascertain the elevation and distance would be when the cross-section is taken. Similarly, in the case of roads in which fences or pole lines constitute a control in the alignment, these features of topography should be measured in and recorded when the cross-sections are taken. The work of cross-sectioning, then, would of necessity have to be recorded to run up the sheets, the H. I's. appearing at the bottom of the page. If no topography is recorded with the cross-sections, the notes may be taken to run down the page.

Cross-sections are to be taken at all profile breaks and in no case should the interval between cross sections exceed 100 feet. The intent of the location survey is to prepare a basis upon which the quantities can be estimated and the locator should use considerable judgment in determining the proper place for the cross-sections. As an illustration, if the line crosses an irrigation ditch at an angle, the proper place for cross-sections would be at points on the line where the outside edge of the ditch would be somewhere near the probable toe of the slope when the project is completed. The cross-sections would then constitute a basis on which the designers could accurately determine the pipe length required and inasmuch as the ditch usually remains constant in shape from one side to the other, the earth

quantities can be satisfactorily determined. The work of cross-sectioning all the breaks at the ditch crossing would then be obviated.

In addition to recording all cross-section readings, profile shots should be noted. Continuing the example in the preceding paragraph, after the cross-section had been taken and before crossing the ditch, profile readings should be taken at the top of the bank, the water surface, the bottom of the ditch on both sides and the water surface again and the top of the opposite bank. Descriptive lines would then be drawn up from the last cross-section through the profile readings to join with the next cross-section and thus show conditions as they actually exist.

7.4161 Accuracy in Cross-Sections Accuracy should be maintained, particularly in recording the rod readings. An engineer's level will be used for all rod readings insofar as is possible. Any elevations on the cross-section which are out of range of the instrument will be determined with a hand level. The relative elevation with respect to the H. I. would then be recorded.

7.4162 Irrigation Systems All irrigation systems within 100 feet of the centerline will be cross-sectioned, the notes to show the water surface, the banks of the ditch, the flow line and the direction of the flow. If the line follows the ditch for any distance the cross-section would then show the wetted perimeter transverse to the flow. Where the ditch crosses the centerline at an angle of approximately 90° the cross-section would not aptly show the wetted perimeter; the flow line would then be run out 100 feet on each side and a cross-section would be taken to show a section transverse to the flow. Any structures existing in the irrigation system should be tied in, both by distance and elevation.

7.4163 Contiguous Drainage Existing drainage facilities on railroads and county roads must be tied to the survey by elevation and distance. A complete description of the structures and elevations of high water marks should be recorded. In this connection it is well to state the legend accepted in the design department to identify drainage structures.

C. M. P.—Corrugated metal pipe.
C. I. P.—Cast iron pipe.
R. C. P.—Reinforced Concrete pipe.

Wooden boxes and concrete boxes will be described as such.

7.4164 Railroads The cross-sections should be extended to railroads when in near proximity at 500-foot intervals and the elevation at the base of the rail and the height of the rail recorded.

7.4165 Channel Changes Where it is apparent that a channel change will be required on the construction, extend the cross-sections to present an accurate and complete picture of the topography.

7.4166 Intersections Take sufficient cross-sections at intersections with existing roads and approaches to show the conditions existing. Draw in the shoulders and any drainage structures in place as specified hereinbefore. Run a profile along the center of the intersecting road or approach for a distance sufficient to show the grade, usually two or three hundred feet. Similar topography should be noted at railroad crossings, the controlling elevations in this case being the tops of the rails.

7.4167 Equations All equations must be cross-sectioned and clearly indicated in the notes.

7.4168 Extent It is obvious that the cross-sections should be extended to cover all the topography which will be confined in the Right of Way tract. As directed herebefore, the cross-sections should also be extended to show any topography outside of the Right of Way tract which will have a definite bearing on the design of the project. If the cross-sections are being taken on a preliminary line they should be extended far enough to provide a basis for projecting the final location. In this work it is well to show the slope of the ground outside the limit of the cross-sections so that if necessary the slope can be extended in the design. Any other features outside the limit of the cross-section should be noted, for example, if borrow were available on a nearby knoll, make a note of this in the cross-section notes.

7.417 Notes All notes pertaining to the work heretofore described including the bench levels, the check levels, cross-sections and incidental topography will be entered and indexed in the "Level and Cross-Section Books." Form recommended for compliance as shown on Plate 111 of the Standards except as it is modified by the instructions in Paragraph 7.416.

7.5 Topography

7.51 General Taking and recording the existing topography constitutes a very important feature of the survey. All details, even those of seeming minor importance shall be recorded.

7.511 Right of Way Some features of the topography will have a direct bearing on the Right of Way negotiations and on the preparation of the Right of Way map and as such they will be discussed:

a. Note the character of the land and its use.

b. If the land is of apparent value by acreage note any convenient or suitable borrow to be end-hauled from cheaper land.

c. Show all existing bridges and state whether or not they are used for stock passes.

d. Give the approximate location of ranch buildings in the area. If the buildings are over 200 feet from the centerline they can be tied in satisfactorily by turning angles from two different points on the survey.

e. Show the location, dimensions and classification of stock passes existing under the present road.

f. If the property owner requests a stock pass make a notation of this with your recommendation.

g. If channel changes, either in drainage ditches or irrigation ditches are needed, sketch in the probable location.

h. Show ditches and structures with the distance and direction of flow which would not come within the limits of the cross-sections.

i. Locate all main county roads within a quarter of a mile of the survey. If the road is more than 500 feet away from the base line, ascertain its location by approximate methods.

j. To supplement the land ties (See Paragraph 7.351) tie all intersecting fences to the centerline by angle and measurement.

k. Describe all fences along the survey as to condition, number of wires, "hog-tight" or otherwise.

l. Show existing farm entrances and note if their use will be modified by the construction of the new road.

7.512 Topography Affecting the Design Certain topographic details will have a very definite bearing on the design. Ordinary topography in this category is cited as follows:

a. Note the classification and its suitability for use in the roadway. If through a swampy area, make a recommendation as to the treatment, either by improvement of drainage facilities or the addition of sub-base material.

b. Note snow conditions and prevailing winds.

c. Note drainage conditions, if scour is apparent record the extent.

d. Show the clearing and grubbing required.

e. Show all sources of borrow whether for the roadway or for sub-base material.

7.513 Utilities Locate all poles within a reasonable distance of the survey. The poles should be designated by number and the number of wires. If two or more pole lines are loated in the vicinity of the survey, connect them by lines in the notes to show their direction and ownership. Any lead-off wires from the pole lines to houses should be so indicated. Where the line crosses a pole line show the clearance from the bottom wire, the angle of intersection and the distances from the survey to the poles on each side. The notes should also indicate the probable division of costs if the poles are to be moved on the highway construction work. Paragraph 1.203 will explain the procedure in dividing the costs.

7.514 Drainage Recommendations Most of our work traverses territory in which roads have already been built by the various counties, and drainage structures existing would constitute a basis for estimating the drainage requirements on the new project. Estimate the openings somewhat in excess of those existing, and pay particular attention to any indications of cloudbursts and the

amount of water usually carried in the channels during the spring run-off. It is preferrable, when the topography warrants, to cut several channels into one and carry the drainage under the highway in a single structure. Any channel changes required to thus concentrate the drainage should be sketched and noted with the topography notes.

7.5141 Side Drainage Side drainage requirements should be noted at all road approaches and at the sites of any road approaches proposed on construction. Consideration should be given to the relation of the probable grade line and the slope of the ground.

7.5142 Irrigation Structures for irrigation channels can be easily estimated as to the opening required. However, it is well to consult the properyt owner as to the tentative location and dimension of the structure. Record of the owner's recommendations should be submitted with those of the locator. Existing structures such as headgates, flumes, dikes and off-take channels should be sketched in detail, so that if proposed for removal, similar structures can be designed to serve their purpose.

7.515 Bridges All streams, large irrigation channels, grade separations should be surveyed as a separate unit of the project and the treatment will be outlined later in the Manual.

7.516 Concrete Boxes Unless specifically required by local conditions all drainage structures should be recommended as pipe culverts. If due to the height of the fill or the demands of a property owner in the vicinity, a concrete box is necessitated, the designing department will determine the waterway area of the structure.

7.517 Notes All notes pertaining to the topographic detail, classification, drainage structures required and clearing and grubbing will be entered in the "Topography Notes." Form recommended for compliance as shown on Plate II of the Standards. Insofar as is possible, all topography will be recorded according to the legend given in the Standards under "CONVENTIONAL SIGNS." If another legend is improvised to cover detail not shown on this standard, it should be noted clearly at the beginning of the notes.

7.6 Incidental Surveys

7.61 Municipal Surveys

7.611 General The Highway Commission is now called upon to construct roads and streets through municipalities. Directions have been given herebefore as to the methods used in aligning the work. In general the survey is similar to that in the suburban areas, however, due to the maze of topographic detail the work calls for special treatment and the methods set forth hereafter are advanced for compliance.

7.612 Meridian Ascertain the true bearings from the recorded plat of the city.

7.613 Located Line The location line should follow the lines given as the centerline of the street on the recorded plat. In staking the line use "plugs" and reference each plug by painting the station number on the curbs. Avoid using stakes as they constitute a physical hazard to the public. For convenience in cross-sectioning, "plugs" and station markers should be placed at the locations prescribed below:

a. Usually the survey will start at a property line and should be marked with a hub.

b. Place stakes opposite the centerline of each alley and opposite the property lines at the alleys.

c. Beginning at the next street property line, put in plugs as follows:

1. Edges of crosswalk.
2. Opposite the beginning of curvature in the curb line.
3. At the intersection of the transverse gutter line and the centerline of the survey.
4. One-half way between the gutter line stake and the centerline of the intersecting street. This will establish the "quarter point" of the intersecting street.
5. The street intersection.
6. The other side of the intersecting street would be staked similarly.
7. These points can be established when running in the survey by using a chalk line at the points designated and intersecting therewith.

7.614 Levels and Cross-Sections

The levels and cross-sections through a municipality should be tied in very definitely with the existing topography. General procedure would be somewhat as follows:

a. Cross-sections—If curbs are in place, readings should be taken in addition to those at all quarter points, at the gutter line, the top of the curb, both edges of the sidewalk and far enough past the property line to clearly illustrate conditions as they exist.

b. Street Intersections—Cross-sections should be taken along the intersecting property line, the crosswalks, the gutter line, far enough to show the grade, the intersecting quarter point line and the centerline of the intersecting street; these last cross-sections to establish the intersecting street grade line for at least 100 feet.

c. Alleys—Cross-sections should be taken down the centerline of the alley and at each alley property line.

d. Topographic Features—Many features of the topography such as sewer man holes, gas valves, water valves and telephone manholes are not readily apparent when the cross-sections are taken, but insofar as is possible without material delay to the party, these details should be incorporated in the cross-section notes. In the event that the manholes, etc., are buried, a separate survey should be made to tie them to the centerline by elevation and distance. Maps are usually available at the city engineer's office or at the utilities' offices showing the location of the structures with reference to the property lines. Common features of topography and the method of tying them in are as follows:

1. Water Mains—The location of water mains is usually indicated by water valve boxes. Reading should be taken on top of the valve box cover and on top of the valves. The main is located generally about twelve inches below the level of the valve.

2. Gas Mains—The location of a gas line is indicated by gas valve boxes and readings should be taken on top of the cover and on top of the valve bolt. General practice on Montana Power gas lines has been to set the pipe thirty inches below the ground surface.

3. Storm and Sanitary Sewers—Sewer lines are indicated by manholes. Readings should be taken on top of the cover and on the inverts at the inlet and outlet to the manholes.

4. Telephone, Telegraph and Power Line Conduits—Manholes will show the location of the conduit and readings should be taken on top of the cover and on the conduit wires.

5. Lights—City light systems are usually connected by underground conduits and the locator should procure a map to ascertain the location of any transverse crossings and get the average depth to which the conduits are laid.

7.615 Topography Generally speaking, the measurements to all topographic details should be recorded in the cross-section notes as stated heretofore. All houses fronting on the proposed improvement should be noted and recorded.

7.62 Bridge Situation Surveys

7.621 General Where the construction of a bridge is deemed necessary, the locator shall make a thorough and complete survey of the area as a basis for the bridge design. The Bridge Situation Survey Report Form, specifies the requisite data to be entered thereon and the field survey shall be conducted accordingly.

7.622 Alignment The design and construction of a bridge is a very precise operation and it is obvious that the location survey should be accurate to a commensurate degree. In staking the area to be surveyed, mark all the breaks along the centerline profile and then transfer the same plusses to offset lines. Any breaks along the profile of the offset lines should be transferred back to the centerline profile and staked. The Report Form requires that a profile twenty feet each side of the centerline be recorded; however, it is not intended that these lines be staked inasmuch as this profile can be computed from the cross-sections. The offset lines should be staked at a distance that will guarantee an accurate survey, probably one hundred feet from the centerline.

It is intended in so laying out the work that the measurement of all topographic detail will be done with precision.

7.623 Cross-Sections To tie in all topography by elevation and distance, it will be necessary that cross-sections be recorded up the page in the notebook.

Indications of low or normal water elevation and high water elevations should be accurately noted and recorded. Incorporate all features of the topography as a part of the cross-sections. Tie all soundings and boring with notes as to the character of the foundation soil and by elevation and distance. Readings should be taken at a distance of twenty feet from the centerline on all cross-sections.

7.624 Topography Ordinarily, all stream crossings constitute the control in laying out the roadway alignment and it rarely occurs that the location is projected from the surveyed line in the vicinity of the bridge site. The topography to be recorded is usually that which would have a very definite bearing on the design and is, if possible, to be recorded with the cross-sections. Any existing structures should be measured and the waterway checked to see if adequate. The channel of the stream should be traced for a considerable distance (as indicated by the Report Form) to indicate the drainage area.

7.625 Field Map On completion of the field survey, all field data shall be reduced and transferred to the Report Form according to the directions and the legend thereon. The plan should show the edges of the stream, the high water contour, and any topographic detail within the scope of the map. Contour intervals can be located from the cross-sections when plotted. In the event that certain important topographic detail cannot be shown on the Report Form, a supplementary map on hardshell at a smaller scale should be prepared. The Report Form, when completed, will constitute a working basis for the Bridge Designing Department and it is important that it be finished in a neat, precise, and legible fashion.

7.63 Railroad Grade Separation Surveys

7.631 General Railroad Grade Separation Surveys shall be made generally according to the directions given in the preceding paragraphs. Accurate ties must be made to the railroad system, special attention being given to making an accurate angle tie. All poles, lines and their clearances signal systems, existing drainage structures and other pertinent data will be measured precisely. The railroad grade shall be indicated by running a profile

along the tops of the rails for a distance of at least 400 feet. Where possible, the railroad alignment and level datum should be tied into the highway datum.

7.632 Field Map All data in the immediate vicinity of the crossing can be shown on a Bridge Situation Survey Report Form. Contour intervals must be shown as for a bridge survey.

A supplementary map should be prepared to show the topography along both the railroad line and the highway line for a distance of at least 1000 feet each side of the crossing. The profile of the highway with relation to that of the railroad should be plotted throughout the length of the survey.

7.64 Building Lay-Outs

7.641 General All sites proposed for State Highway buildings to be erected by state forces or by contract, shall be surveyed and layout maps prepared by the engineering staff. The surveys shall be accurate and located with reference to sub-division lines and existing utilities. Inasmuch as buildings, constitute a part of the capital assets, special charges will be issued from the Headquarters Office to cover all expenditures incident to the survey. Important points to be considered in the survey are as follows:

a. Tie in the site by showing lots and blocks, also streets and alleys, by name and number
b. Show all fire hazards in the vicinity.
c. Tie to water mains, fire hydrants, gas mains, sewer lines, etc.
d. Show measurements of adjoining buildings.
e. Draw map to a scale sufficiently large to indicate all measurements taken in the field survey.
f. Indicate topography by showing contours.

7.7 Location Field Drafting

7.71 General Location field drafting is a very necessary and important adjunct of the survey. The map and the profile as presented to the design department will be the working drawings and it is essential that all details be accurately and clearly pictured.

7.72 Alignment All field transit work must be checked as to bearings and curve data. On completion of this detail, the drafts-

man will prepare the co-ordinates (Form No. 16A) and this in turn must be checked before the map is drawn. The co-ordinates will then be laid out on the hardshell and special effort should be made to prevent breaking the line, i. e., lay out the co-ordinates so that the centerline will stay on the sheet as long as possible. If the line runs off the hardshell repeat enough on the next section so that the tracers in Helena will not be inconvenienced. General notes advanced for compliance are as follows:

a. Scale—All locations in suburban areas will be drawn on a scale of 1″=200′. Locations in urban areas or where topographic detail is condensed will be drawn on a scale of 1″=50′.

b. Form—Alignment and curve data will be plotted according to the form in the Plans Department Standards.

c. Incidentals—A map drawn with a 6H pencil is satisfactory to the designing department, providing the lines are drawn in a clear, sharp outline.

7.73 Ties All angle ties to section lines, fence crossings and important structures, should be shown on the map along with the distance and the highway stationing. The standard legend is given in the Standards under "CONVENTIONAL SIGNS."

7.74 Topography Sketch in all topography as noted in the field, both in the cross-section notes and the topography notes. In the event that the topographic detail is very involved assign colored inks to the various structures to distinguish them further. This would be applicable in city surveys where a number of pole lines of different ownership are in place or where various underground systems are used, such as sewers, water lines and gas mains. In the event that inks are used on the map, consideration should be given to the standard use of colors given as follows:

a. Black—Centerline and ordinary topography.

b. Blue—Streams, rivers and irrigation systems.

c. Brown—Contours.

The legend to be used in drawing in the topography will conform to that shown in the Standards under

"CONVENTIONAL SIGNS" and "PLANS DEPARTMENT STANDARDS." The knowledge conveyed by use of the standard symbols should be supplemented by a description of the topographic feature written in on the map in a manner similar to that used in describing structures on the finished plans.

7.75 Profile The level and cross-section notes should be checked and certified correct by the field draftsman. The profile will then be plotted using a scale of 1″=100′ horizontally and 1″=10′ vertically. The plotting should then be checked and if correct, inked. All existing drainage structures should be shown on the profile, also, as in the case of city surveys, the sewer line grade, water mains grade, etc.

The profile will serve as the chief working drawing on the design and certain other features should be noted as signified below:

a. Show alignment, i. e., beginning and end of curves and the degree of these curves.

b. Show the openings of any drainage structures proposed and the probable location.

c. Note the classification.

d. Note the clearing and grubbing.

e. Where unusual conditions exist, show controlling grade points and give reasons. Do not use red pencil at any time on the hardshell. Observe the standard controlling the minimum distance between grade breaks and the length of vertical curves to afford satisfactory sight distances.

Form for compliance is shown on the "PLANS DEPARTMENT STANDARDS".

7.76 Cross-Sections Cross-sections will not be plotted in the field. If time is available the elevations may be computed and, if so, will be certified by the initials of the party who figured them.

7.77 Ownership The names of all property owners along the line of the survey must be recorded on the map along with a description of the land they own in the vicinity. This information can be procured from the County Assessor and should be checked against the deed records in the

County Clerk and Recorder's office. In many cases the records of the County Assessor will be neither complete nor orderly; in this event, the locator should secure the ownership through an Abstractor's office, providing the cost of securing the ownership will not exceed ten dollars.

7.8 Letter of Transmittal

On completion of the field survey, the notes, profile map and other supporting data will be forwarded to the Division Office for check and transmittal to Helena. A conforming letter should be forwarded to the Division Office in which all field data is itemized and also the probable design is discussed with relation to existing field conditions. The form of the letter would comply generally with the following:

a. Alignment—Describe the alignment and give the original controls under which the line was staked. If, during the course of the survey the line was changed somewhat from the controls recommended in the reconnaisance report, explain the change in detail.

b. Grades—Cite all absolute grade controls; describe snow conditions governing the selection of the grade and similarly the condition of the foundation soil through swampy areas.

c. Drainage—Give a general discussion of the drainage facilities offered in the area. If any irrigation structures have been recommended at the request of the property owners, state this fact. Any other features which would have a bearing on the drainage structures required should be discussed in full.

d. Miscellaneous—Elaborate on all pertinent features of the design as based on field conditions; if the notes are not absolutely clear make them so in your letter. It is to be remembered that the designers in many cases will not be familiar with the country through which the survey is going.

e. Contiguous Construction—In many cases, particularly through settled areas, the Commission is called upon to construct footpaths, parking places, new curbs and gutters, headgates, etc. Any features of the work such as those cited above are to be discussed in full for the convenience of the Designing Department.

7.9 Pre-Construction Sampling

7.91 General Contractors base their estimated costs for improving a roadway on the location and the extent of materials available. Therefore, in the interests of economy, the locator should make a careful and exhaustive survey of all materials available for use in the construction of the roadway. The design of the highway is also dependent, somewhat, on the materials available for use since it is desirable to utilize local deposits both for surfacing and for the aggregates.

7.92 Surfacing Samples Surfacing samples must be taken to truly represent the materials in the deposit in their entirety, i. e., to the extent to which future crushing operations will probably exhaust the pit. This will, in many cases, necessitate that large test pits be dug, and to safeguard stock the test pits should be filled again when the samples are procured.

The materials available in the various sections of the state are dependent on the local geologic structure; however, all deposits should be sampled as a basis for the estimate and the design.

7.921 Identification Surfacing pits can serve also as a source for sub-base materials and if it is apparent that this material will be necessary in the construction of the road, identify the sample as representing the material available for both crushed surfacing and sub-base gravel.

Sample report form No. 92, if completely filled out, will serve as a satisfactory means to locate the tested material. If the deposit is away from the survey a considerable distance, locate it with reference to some local road in addition to a description of the land by sections and portions of sections.

7.93 Pit Report Report Form No. 92 will be made in quadruplicate, the original being sent direct to the testing laboratory, the duplicate being enclosed with the sample, the triplicate being sent the Division Engineer and the quadruplicate being retained in the field. The Testing Laboratory will conduct complete tests on all pre-construction samples submitted, sending two copies (Form No. 47) of

the test results to the Division Engineer under whose direction the original samples were submitted.

7.94 Consigning the Sample As stipulated on the bottom of the Pit Report form, the sample should weigh not less than thirty pounds when taken. The testing laboratory furnishes sacks on requisition for the purpose of shipping the sample and all shipments will be consigned thereto by express collect. The shipment will be identified by attaching two shipping tags, these to be addressed to the testing laboratory and give information similar to that shown on the Pit Report Form.

7.95 Concrete Aggregates Concrete aggregate samples will be taken and submitted to Helena according to the directions given for Surfacing Samples.

7.96 Miscellaneous Other materials to be used in the construction of the road will be sampled on request of the testing laboratory.

CHAPTER VIII

FUNDS AND ACCOUNTING

8.1 Sources of Funds Pre-construction: Funds for all pre-construction engineering and the administration thereof are derived primarily from the Motor Vehicle Fund or Gas Tax.

Construction: Construction funds for expenses incident to construction work and the administration and supervision thereof are likewise drawn from the Motor Vehicle Fund in the amount available or needed to match Federal Aid funds advanced to the State. The Federal Government participates in whole or in part in the costs incident to construction as shown on the detail estimates, including such items of expense as are prompted by the resident engineers, project engineers, staking parties and inspectors when incurred subsequent to the award of contracts.

Participating funds are available only during the life of the contract (when the project is accepted, all accounts should be closed) however, a reasonable extension of time is granted to submit the final estimate or complete other necessary field work.

8.2 Financial Control The preliminary financing of work in the Pre-construction and the Construction Department is dependent generally on the appropriations allocated the State by the Federal Government under the provisions of the Emergency Programs and the Federal Highway Act. The amount of the appropriation will thus control the preliminary and preparatory expenditures for subsequent construction work and the field supervision thereof.

8.21 Allotments Federal Aid Funds, or Emergency Funds are then allotted to the twelve financial districts within the State, each district having been apportioned a set percentage of the whole. On request of the Commission and recommendation of the State Highway Engineer, certain routings within the districts will be designated for improvement; the character and the extent of the improvement to be limited by the moneys allotted the

district and other controlling factors specified in the programs as to the amounts to be expended on primary roads, grade separations, etc.

8.3 Procedure On approval of the routing by the Bureau of Public Roads, the Accounting Department, at the request of the Construction Department, assigns a work order number, this to be superceded by a project number assigned by the Office Engineer with the concurrence of the Bureau. The basis for initial engineering charges, other than those purely administrative is thus instituted and as the project progresses through the various stages from location to completion of construction work, codes will apply to identify and segregate all expenditures.

8.4 Accounts All charges in the Pre-construction and the Construction Departments are classified under one of five heads, viz: Administrative, Operative Engineering, Right of Way Payments, Construction Force Account, and Construction Payments.

8.41 Administrative Code Letter "A" Administrative charges are incurred by those members of the organization serving in or for an executive capacity in the Headquarters Office and also in the Division Offices. In short, it can be said that administrative work is not susceptible to segregation by projects.

8.42 Operative Engineering Charges to operative engineering are incurred in the execution of the recommendations issued through the administrative section; the expenses thus accruing are segregated and charged to individual projects.

8.421 Pre-construction Code Letter "PC" All expenses incident and preparatory to award of contracts including the routing, location and design are to be charged to operative engineering. The Federal Government does not participate in the expenses incident to pre-construction activities.

8.422 Construction Code Letter "C" Operative engineering expenses incurred in the supervision of construction work are to be segregated in two sub-headings, those eligible for Federal Aid and those not eligible. The first classification would include the expenses incurred through

the activities of the resident engineers, the project engineers, and their assistants. The latter classification would include the expenses incured by the Division Engineers and Testing Engineers.

8.43 Right of Way Payments, Code Letter "RW" Right of Way payments and appurtenant charges as a part of the construction expense are not subject to participation. Administration of the account can be initiated in the field or through the office of the Right of Way agent.

8.44 Construction Force Account Code Letter "CFA" When expenses are incurred by state forces doing work which would answer to the descriptions entered under a contract, the account is chargeable to Construction Force Account and may or may not be subject to participation. If in the first category, special force account codes will be issued from the Headquarters Office covering all force account work on which Federal Aid is involved.

8.45 Construction Payments, Code Letter "C" Construction payments are charged under four headings, viz: Payments to contractors, Payments to counties, Force account work, Payments for State furnished materials, and Payments for removals, damage, etc. These payment charges will be discussed below as they apply in the Construction Department.

8.451 Payments to Contractor Payments to contractors are controlled by Progress Estimates submitted from the field.

8.452 Payments to Counties Force Account Work This charge is uncommon in that counties operating as a unit do not ordinarily perform work for the State Highway Commission. As the heading implies, the payments are made to the counties for work performed on a force account basis.

8.453 Payments for Materials Material furnished by the State for installation or use on contracted construction work will be charged against this heading according to written instructions from the Headquarters' Office.

8.454 Payments for Removals, Damages, etc. Payments under this charge will apply particularly on the cost for the removal and replacement of pole lines. Extra Work Orders (See Paragraph 1.238 and 211a will be submitted with the final estimate to provide the basis for the charge.

8.5 Code Numbers The code letters serve to identify the charges incurred under the heading described heretofore and the information thus advanced is further amplified by the use of numbers to denote the class of work performed. These numbers and the corresponding classification are given in the succeeding chapter.

8.6 Suffixes Having classified the work under the proper headings by the use of code letters and numbers, the account is extended to classify the items within the sub-headings denoted by the code letters and numbers. These suffixes and the corresponding segregation are shown in the succeeding chapter.

8.7 Coding

8.71 Pre-construction Work Orders In writing a charge, use first the work order number as for example, WO 1143. This would then indicate the location of the work. The charge would then be extended to classify the work within the department and re-classified by suffix to show the ultimate distribution. As an example, the payroll charge for the aforementioned work order would be WO-1143-PC11-01.

8.72 Pre-construction Project Nos. Project numbers when assigned to pre-construction work are not ordinarily limited by use of a letter to confine the work along the routing. If the program is identified by letters prefixed to the project number, these letters would be entered as an essential part of the charge when made. Unit numbers are not usually assigned prior to construction and will not be considered as a possibility in the following example. The pre-construction charge for car repairs on the Roosevelt Drive road in Silver Bow County would be

WPSO 364-PC11-03, assuming that the expenses were incurred on the location survey.

8.73 Construction Construction charges are prefixed by the project number and identifying letters and unit numbers as shown on the detail estimate. A typical participation charge would be exemplified below:

WPGH 77-A, Unit 2—C17-02

The job would thus indicate that the work under way was on section "A" of the Helena-Bozeman road the provisions of the U. S. Works Program to include a grade separation structure and approaches thereto. The unit number would signify the sequence of the improvement in the history of the project. The code lettering and suffixes would establish the charge as being liable for participation and that the expense incurred was for subsistence of any such charge in that category.

8.74 Miscellaneous It is the intent of the Highway Commission that purchases will be localized or centralized at one point in the several communities of the State and it devolves upon the Project Engineer, he being resident in the district, to distribute charges for other departments in the organization. In most cases the charges will be properly shown on E. F. P. O's., however, they should be checked against the coding given in the succeeding chapter. Following are examples of coding commonly encountered, it being anticipated that the program identification letters are known:

160-D, Unit 1—CFA 19-01 for common excavation and borrow done by State forces.

149-E—RW 15-01 for right of way claims.

3-MA-21 Maintenance charge (check with resident maintenance engineer for correct charges.)

8.75 Coding Claims Distribution shall be shown on the face of the original and duplicate invoices and claims in a legible and orderly manner. If there is not sufficient space on the face of the invoices or claims, distribution shall be shown on the back by turning the bill or claim in tumble form. In no case shall the distribution be shown on the short form jurat. The arrangement of the coding shall at all times be grouped according to (1) Administration, (2) Pre-construction, (3) Construc-

tion, (4) Construction Force Account, (5) Right of Way, (6) M-20- Maintenance Supervision, (7) Maintenance. Under these captions the charges shall appear in numerical order. The following example will illustrate the correct form of coding:

A 11-03	$ 1.50
A 11-04	.45
149-E, Unit 1, PC 11-03	3.00
252-C PC 11-04	3.25
132-E, Unit 2, C 16-03	4.65
132-E, Unit 2, C 17-03	6.55
132-E, Unit 2, C 17-04	5.20
235-D, Unit 4, CFA 1912	4.45
236-B, Unit 4, CFA 1932-a	5.55
236-B, Unit 4, CFA 1932-f	3.67
252C, RW 15-03	8.32
M 20-JD-03	16.55
3 MA-21	3.56
3 MA-25	25.66
3 MA-2-21d	9.65
3 MA-7-32c	16.55
3 MA-10-47	21.66
3 MA-11-52d	1.55
50 MA-22	2.44
	$144.21

The total of the distribution must in all cases agree with the total of the claim and purchase orders.

8.8 Purchases General

(e) **Purchases.** With the exception of emergency purchases, all purchases are to be made through the State Purchasing Agent on requisition or from dealers authorized by the State Purchasing Agent. All materials, supplies, etc., need of which can be anticipated, shall be requisitioned. On small purchases, which will probably be made locally, dealers' bids should be submitted with the requisition. Gravel or rock for surfacing shall be requisitioned, giving name of owner of pit, price, and approximate yardage to be used. The authorized dealers are to furnish materials and supplies on a monthly basis, purchases to be confirmed at the close of the month by the State Purchasing Agent. At the time purchases are made from authorized dealers a field purchase order (No. 2a) shall be given. At the close of the month a bill shall

be submitted by the dealer, invoiced in triplicate, with jurats in duplicate, accompanied by the original emergency field purchase orders (No. 2a). This bill shall be checked and approved in the Division Office, yellow copies of Emergency Field Purchase Orders attached, and a request made on Form 76 that the purchases be confirmed. This requisition (Form 76) should show the first and last dates appearing on the invoice with a notation requesting that the purchases on the attached claim be confirmed, together with a general explanation as to why it was necessary to make purchases on E. F. P. O. This explanation should not refer to that given on individual E. F. P. O's., or be just a form statement such as "Could not be anticipated," etc. The claim should then be forwarded to Headquarters for further attention. The Equipment Department will list the items covered by the invoice on the Purchasing Department's confirmation requisition form, assigning a purchase order number to the confirmation requisition. A copy of this requisition will be returned, together with the duplicate of the requisition (Form 76) to the Division Office. This procedure will eliminate the necessity of itemizing requisitions in the field and the delay in clearing this class of claims for payment. Where a requisition covers a request for supplies to be purchased, the duplicate of Form 76 will be returned to the Division Office with the number of the requisition submitted to the Purchasing Department. When the purchase order has been issued the yellow or quadruplicate copy will be mailed direct to the source of the requisition. In submitting claims covering purchases of this nature the District Office will attach this yellow copy of the purchase order to the invoice in triplicate and jurat in duplicate before sending to Division Offices where the yellow copy of the purchase order will be retained for their files after the claim has been checked and approved

8.81 Purchase of Gas, Oil, Grease

Contracts for supplying gas, (with the exception of carload purchases), oil, and grease are let by the State Purchasing Agent for six-month periods. Upon a request from Headquarters, the Division Engineers shall furnish a list of dealers in the respective towns in their divisions who are capable of supplying the necessary service. In cases where a contract is given and the service is not

satisfactory. Division Engineers will promptly report to Headquarters, giving in detail, the reasons why the dealer is not giving satisfactory service. Headquarters Office will then request the State Purchasing Agent to cancel the contract and enter into a new contract with another dealer. In cases where gas, oil and grease cannot be obtained from the contract dealer, due to the fact that his place of business is closed or he is out of stock, purchases may be made from dealers who have no contract, on emergency field purchase orders, making a notation in the remark column or on the back thereof, showing the reason for the purchase, for instance, "Contract Station Closed." An emergency field purchase order must be issued for all purchases of gas, oil, and grease, regardless of the fact that the purchase is covered by a state purchase order contract.

8.82 Emergency Purchases

Emergency field purchases are to be made when a delay in securing supplies or parts through the Purchasing Agent or his authorized dealers would result in loss of time of employees and laying up of equipment or incurring loss to the Department. The purchases shall be made on an emergency field purchase order at the best price obtainable, and the purchase shall not be confirmed if amounting to $1.50 or less. Emergency field purchase orders shall be issued in all cases of emergency purchases at the time of the purchase. The practice of writing emergency field purchase orders when the bill covering monthly purchases is received will not be tolerated. Division Engineers shall be held responsible for all emergency field purchase order books and they should be issued to no one but responsible employees. Emergency field purchase orders must be signed by the person making the purchase, and show the details of the purchase, account, code and equipment number.

8.9 Claims General

(f) **Claims.** All claims against the Commission for personal expense, labor (to be paid from the revolving fund), freight, express, telephone and telegraph, shall be made in duplicate on Form 23. These claims need not be covered by purchase orders. All other claims for materials and supplies shall consist of three copies of the vendor's invoice with jurats in duplicate and necessary purchase orders, this in-

cludes emergency purchases as well as all purchases made or confirmed by the State Purchasing Agent.

8.91 Claims Gas and Oil When the vendor holds a contract for the delivery of gasoline, and purchases are made of oil, storage, etc., not included in his contract, he shall include these items in his claim covering gas, in the same manner as if covered by the contract. It is not necessary to issue separate emergency field purchase orders for the miscellaneous items except as noted in the following paragraph.

When the vendor is acting as an agent for a manufacturer of gasoline and he delivers oil, storage, etc., for his own account, a separate claim shall be submitted for the gas in the name of the manufacturer having the contract, with emergency field purchase orders attached, and a claim shall be submitted in his own name for oil, storage, etc., with emergency field purchase orders attached. This claim shall be approved in the regular manner and forwarded to Headquarters with request for confirmation. In this case it will be necessary to issue separate emergency field purchase orders. The reason for this is readily apparent when one understands that when we buy from a manufacturer, the State Highway Commission is exempt from paying the Federal Gas Tax, and when purchases are made from other than a manufacturer, the tax must be paid.

8.92 Submission Field men shall be responsible for the prompt submission of claims. Assistance may be given to vendors when needed, but it shall not be the policy of the Department to prepare claims for the vendor. All claims shall be submitted through the Division Office where they shall be checked in every detail, and approved, before submitting to Headquarters.

CHAPTER IX

ACCOUNT CODE AND CLASSIFICATION

Note: Always use both the proper prefix and suffix, for example—C17-01; PC11-03; M22-04.

ADMINISTRATIVE CODE
HELENA & DIVISION OFFICES
PREFIXES
DEPARTMENT DIVISIONS
CODE LETTER "A"

Helena Office

A1 Commissioner and commission

A2 Chief Engineer and staff—including chief, assistant chief, construction engineers and such other personnel as may be assigned.

A3 Bridge division—including bridge engineer and assistants

A4 Accounting division

A5 Stenographic division—including secretary and chief clerk, stenographers, and file clerk.

A6 Office engineering division—including office engineer and assistants, estimate and federal aid clerks

A7 Drafting division (only such time that is not chargeable to pre-construction, construction or maintenance)

A8 Testing division (only such time that is not chargeable to pre-construction, construction or maintenance)

A10 Helena office—general and miscellaneous account.

A201 Tourist Traffic Industry Survey

A202 Personnel Division

A203 Construction Division

Field Division Offices

A11 Division office No. 1, Butte

A12 Division office No. 2, Great Falls

A13 Division office No. 3, Billings

A14 Division office No. 4, Wolf Point

A15 Division office No. 5, Missoula

A16 Division office No. 6, Kalispell

A17 Division office No. 7, Havre
A18 Border Transport Inspection
A19 Division office No. 8, Miles City
A20 Division office No. 9, Lewistown
A21 Division office No. 10, Bozeman

01

HELENA & DIVISION OFFICES
SUFFIXES
DEPARTMENT DIVISIONS
CLASSIFICATION OF ITEMS

01 Salaries only
02 Railway and other transportation and personal expenses including board, room, railway transportation requests or mileage, pullman accommodations, auto, team and sadle horse hire, and subsistence stores
03 Automobile supplies and repairs
04 Miscellaneous personal supplies and services paid personally—includes postage, telephone, telegraph, etc.
05 Maintenance office equipment.
06 Rental office equipment
07 Office telephone and telegraph
08 Express, freight, and drayage
09 Office supplies
10 Postage and stamped envelopes
11 Premium employees bond and Notary commission
12 Industrial accident insurance
13 Fire and liability insurance
14 Blue print supplies
15 Technical publications, magazines, association dues, etc.
16 Heat, light, power, rent, and janitor
17 Federal aid general expense
18 Maintenance field engineering equipment
19 Field engineering supplies
20 Drafting room supplies
21 Legal advice

22 Photographs and highway maps
23 Testing supplies
24 Outside sampling
25 Mess supplies
27 Traffic census (used with M20)
28 Standard plans
29 Specifications
34
35 Fair exhibit
36 Biennial report and BPR financial reports
37 Conference expense
38 Legislative and advertising
39 Expense incurred in contract letting
40 Bond sale expense
41 County engineering expense and consultations
42 Preparation of Field Manuals
43
44
45
46 Governor's expense

EQUIPMENT DIVISION—HELENA
PREFIX
CODE LETTER "A"

A-9 Equipment division—includes mechanical supt., shop foreman, clerks (office or stock) or any labor or supplies not allocatable to specific job

SUFFIXES
CLASSIFICATION OF ITEMS

01 Salaries only

02 Railway and other transportation and personal expenses including board, room, railway transportaton requests or mileage, pullman accommodations, auto, team and saddle horse hire, etc.

03 Automobile supplies and repairs

04 Miscellaneous personal supplies and services paid personally—includes postage, telephone, telegraph, etc.
05 Maintenance office equipment
06 Rental of office equipment
07 Telephone and telegraph
09 Office supplies, etc.
10 Postage and stamped envelopes
16 Heat, light, power and rent
26 Machine shop supplies
30 Maintenance—road and fence
31 Maintenance of rented equipment
32 Maintenance of shop equipment
33 Suspense clearing account

OPERATIVE ENGINEERING PREFIXES PROJECT NUMBER AND PRE-CONSTRUCTION CODE LETTER P. C.

P.C. 10 Reconnaisance
P.C. 11 Preliminary and location survey, roads
P.C. 311 Preliminary and location survey, bridges
P.C. 12 Plans, specifications and estimates, roads
P.C. 312 Plans, specifications and estimates, bridges
P.C. 13 Location and testing materials
P.C. 14 Plan in hand inspection
P.C. 15 Advertising and contract letting
P.C. 15-2 Right of way expense, including maps, etc.
P.C. 316 Test holes for bridge foundations
P.C. 50 Beautification

SUFFIXES
OPERATING ENGINEERING

01 Salaries only
02 Railway and other transportation and personal expense, including board, room, railway transportation request or mileage, pullman accommodations, auto, team and saddle horse hire and subsistence stores
03 Automobile supplies and repairs
04 Supplies—telephone and telegraph, postage, and all miscellaneous expense

Note: When tests are made of materials for a project in the preconstruction stage, the charge will be made by the testing division or the employee obtaining samples to P.C. 13.

RIGHT OF WAY PAYMENTS
(Construction Item)
PREFIX PROJECT NUMBER AND "RW"
CLASSIFICATION OF ITEMS

RW-15-01	Salaries only
RW-15-02	Railroad transportation
RW-15-03	Automobile expense
RW-15-04	Miscellaneous
RW-15-12	Right of way maps
RW-15-29	Fencing allowance
RW-15-30	Damages
RW-15-31	Purchase of real property
RW-15-32	Payments of judgments granted by court
RW-15-33	Attorney fees, court costs
RW-15-38	Gravel pits
RW-15-39	Miscellaneous right of way expenses

OPERATIVE ENGINEERING
PREFIXES
CONSTRUCTION CODE LETTER "C"
PREFIXED BY PROJECT NUMBER AND UNIT

C16 Supervision and nonparticipation charges by:
Division heads
Field division engineers
Testing engineers
and all other nonparticipation items

C17 Construction engineering charges by:
Resident supervisors
Staking parties
Inspectors
and all other charges eligible for Fed. Aid.

SUFFIXES
OPERATIVE ENGINEERING

01 Salaries only

02 Railway and other transportation and personal expense, including board, room, railway transportation request or mileage, pullman accommodations, auto, team and saddle horse hire, and subsistence stores

03 Automobile supplies and repairs

04 Supplies—telephone and telegraph, postage, and all miscellaneous expense

Note: When tests are made of materials for a project in the construction stage, the charge will be made by the testing division or by the employee obtaining samples, to C16.

The classification of laborer, truck driver, sectionmen, teamster, and maintenance engineer is not eligible for Federal Aid and must not be coded C17, except when a satisfactory explanation can be given. When employees of this class are used, a memorandum must be attached to the construction payroll giving a full explanation.

CONSTRUCTION PAYMENTS
PREFIX "C"
NO. 18
PREFIXED BY PROJECT NUMBER AND UNIT

C1801	Payments to contractor
C1802	Payments to counties, force account work
C1803	Payments for materials
C1804	Payment for removals, damage, etc.

CONSTRUCTION FORCE ACCOUNT
PREFIX "CFA"
NO. 19
PREFIXED BY PROJECT NUMBER AND UNIT

CFA1901	Common excavation and borrow
CFA1902	Rock excavation
CFA1903	Intermediate excavation
CFA1904	Overhaul
CFA1905	Retaining wall
CFA1906	Drainage structures—includes culverts, all labor and material
CFA1907	Removal (tel. tel. and fences)
CFA1908	Random rip rap
CFA1909	Clearing
CFA1910	Guard rail
CFA1911	Cattle passes
CFA1912a	State furnished gravel
CFA1912b	Binder
CFA1912c	Overhaul on binder
CFA1912d	Processing
CFA1912e	Hauling
CFA1912g	Preparation of grade
CFA1913	Mess house operation (deductions for board to be credited to)
CFA1914	Building temporary road
CFA1915	Moving camp
CFA1916	Transportation, supplies, materials and mess supplies

CFA1917 Snow fence
CFA1918 Office expense
CFA1919 Transportation
CFA1920 Camp equipment
CFA1921 Allowance to convicts
CFA1922 Planting trees

Note: In addition to the above code CFA19, **special force account codes will be issued from Headquarters covering all force account work on which Federal Aid is involved.**

OPERATIVE ENGINEERING PREFIXES MAINTENANCE CODE LETTER "M"

M20 General Supervision by Maintenance Superintendent and Assistants, Field Division Engineers
Suffix—Initials of Engineer incurring expense. For example: M20-EBD-03

M22 Maintenance
(See sub-divisions set up in Maintenance Code)

M22-01 General—Salaries on Vacation.

M30 Distribution of Gasoline and Oil from Storage
Prefix M30—Suffixes 1 to 12

- 1 Butte
- 2 Great Falls
- 3 Billings
- 4 Wolf Point
- 5 Missoula
- 6 Havre
- 7 Bozeman
- 8 Lewistown
- 9 Glendive
-10 Helena
-11 Miles City
-12 Kalispell

Each suffix shall carry all charges for labor and supplies.

M21 Holding Account for Equipment Overhaul
- -1 Division One
- -2 Division Two
- -3 Division Three
- -4 Division Four
- -5 Division Five
- -6 Helena Shop
- -7 Division Six
- -8 Division Seven
- -9 Division Eight
- -10 Division Nine
- -11 Division Ten

Each suffix shall carry all charges for labor and material. This account shall be credited for all charges transferred or distributed to Maintenance and Construction accounts.

CONSTRUCTION PAYMENTS
SIGNING HIGHWAYS

S23	General Signing Expense
SA23	U. S. 10 Yellowstone trail U. S. 10 North and U. S. 10 South
SB23	U. S. 12 Baker-Terry
SC23	U. S. 87 Gardiner-Neihart and U. S. 87 West
SD23	Mont. 110 Junction with U. S. 10S near Crackerville thru Anaconda and Philipsburg to Junction with U. S. 10 at Drummond
SE23	U. S. 2 Roosevelt Highway
SF23	U. S. 87 East— Y. G. B South of Neihart
SG23	U. S. 91 Dillon-Butte-Helena-Great Falls
SH23	U. S. 93 Hamilton-Missoula-Kalispell-Eureka
SI23	U. S. 310 Frannie-Laurel
SJ23	Mont. 3 Junction with U. S. 93 at Ravalli thru Paradise, Plains, Thompson Falls to Idaho line near Heron
SK23	Mont. 11 Junction with U. S. 87 at Vaughn thru Conrad and Shelby to the Canadian line
SL23	Mont. 14 Junction with U. S. 10 at Glendive North thru Sidney to State line near Fairview
SM23	Mont. 22 Wyoming line near Alzada North thru Broadus, Miles City, Jordan, Glasgow and Opheim to the Canadian line
SN23	Mont. 29 Junction with U. S. 87 at Great Falls North thru Fort Benton and Havre to the Canadian line
SP23	Marking Historical and Scenic Points Throughout the State

SUFFIXES

a Labor only
b Railroad and other transportation
c Automobile supplies and repairs
d Materials, tools and supplies
e Supervision

No charge to be made this a/c except by signing crew. "See Maintenance Code 28 for sign repairs."

CAPITAL ASSETS
PREFIX LETTER "CA"
OFFICE FURNITURE AND FIXTURES

CA-40	Office furniture and equipment
40-1	Commissioner's office
40-2	Chief engineer and Ass't. office
40-3	Bridge division
40-4	Accounting division
40-5	Gen. clerical division
40-6	Gen. office engineering division
40-7	Gen. office drafting division
40-8	Testing division
40-9	Equipment division
40-21	Personnel Department
40-203	Construction Department
40-RW	Right of way division
40-D1	Division office, Butte
D2	Division office, Great Falls
D3	Division office, Billings
D4	Division office, Wolf Point
D5	Division office, Missoula
D6	Division office, Havre
D7	Division office, Lewistown
D8	Division office, Bozeman
D9	District office, Glendive
D11	Division office, Kalispell
D12	Division office, Miles City

CA-41	Engineering equipment
41-1	Instruments
41-2	Tools
41-3	Camp equipment

The above accounts require an inventory of office furniture and equipment to be submitted as of June 30 for each fiscal year. This inventory shall be separate for each office in the Capitol, Division and District office.

CAPITAL ASSETS
BUILDINGS—PREFIX LETTER "CA"

CA42-6	Helena
7	Great Falls
8	Bozeman
9	Havre
10	Billings
11	Wolf Point
12	Butte
13	Missoula
14	Lewistown
15	Helena office building
16	McDonald Pass Station
17	
18	
19	Kalispell
30	Holding a/c for Port of Entry houses
31	Columbia Falls
32	Culbertson
33	Gardiner
34	Miles City
35	Missoula
36	Monida
37	Rockvale
38	West Yellowstone
39	Wyola

Suffixes—Classification of Cost Items

(61 to 79 for use with State Forces)

CA42-6-60	Payments to contractor
1	Labor shop building
2	Labor power and lights
3	Labor heating plant
4	Labor water and sewer
5	Labor bins
6	Labor office
7	Labor hangars and outside stores
8	Labor driveway, fence, and railroad spurs
9	Labor painting
71	Material shop building
2	" power and lights
3	" heating plant
4	" water and sewer
5	" bins
6	" office
7	" hangars
8	" driveway, fence and railroad spurs
9	" painting
80	Deductions from contractor
1	Purchase of land
2	Architect's fees and advertising
3	Trees and planting
5	Miscellaneous: gas, oil and repair
90	Depreciation

Note: When a new building or addition is added, a sub a/c (CA42A, etc.) will be assigned by the Helena office for the purpose of assembling all charges incurred for construction. This sub a/c will be closed into CA42 on completion.

CAPITAL ASSETS
PREFIX LETTER "CA"

CA44 Shop Tool equipment

SUFFIXES

1 Missoula
2 Great Falls
3 Billings
4 Wolf Point
5 Butte
6 Havre
7 Lewistown
8 Bozeman
9 Glendive
10 Helena
11 Kalispell
12 Miles City
13 Livingston

The suffixes of this code shall include all charges for freight, drayage and handling.

An inventory must be submitted to the Equipment Superintendent at Helena as of June 30 of each year and at more frequent intervals if he requests it.

CAPITAL ASSETS
STORAGE FACILITIES FOR CARLOAD STORAGE OF GASOLINE AND ROAD OIL
PREFIX LETTER "CA"
(Formerly a/c E-26)

CA45-10	Billings
11	Great Falls
12	Butte
13	
14	Wolf Point
15	Missoula
16	Havre
17	Bozeman
18	Lewistown
19	Glendive
20	Helena
21	Miles City
22	Kalispell

This code shall carry all charges for tanks, motors, pumps, pipe lines, loading platforms and labor for installing. In all cases where new units are installed, the Helena office will issue authority for a sub-account (CA-45-10A, etc.) in order that the cost may be assembled for each unit. Complete details covering the unit to be installed, such as location, size or capacity, railroad facilities, etc., shall be furnished the Helena office when making a request for a new or additional installation.

CAPITAL ASSETS
REPAIRS AND MAINTENANCE OF SHOP BUILDINGS
PREFIX LETTER "CA"

CA47-6	Helena
7	Great Falls
8	Bozeman
9	Havre
10	Billings
11	Wolf Point
12	Butte
13	Missoula
14	Lewistown
15	Helena office building
16	McDonald Pass Station
17	
18	
19	Kalispell
20	Repairs and alterations rented quarters

Suffixes and Classification of Cost Items

(61 to 79 for use with State Forces)

CA47-6-60	Payments to contractors
1	Labor shop building
2	Labor power and lights
3	Labor heating plant
4	Labor water and sewer
5	Labor bins
6	Labor office
7	Labor hangars and outside stores
8	Labor driveway and fence
9	Labor painting
71	Material shop building
2	" power and lights
3	" heating plant
4	" water and sewer
5	" bins
6	" office
7	" hangars
8	" driveway and fence
9	" painting
80	Deductions from contractor
3	Trees and shrubbery
4	Fire loss and repairs

Note: Account CA47 to be closed to Depreciation a/c.

CAPITAL ASSETS
PREFIX LETTER "CA"
INVENTORY REQUIRED AS OF JUNE 30

CA50 Major Equipment

1 Automobiles
2 Trucks
3 Tractors
4 Power graders and scarifiers
5 Crushers and gravel plants
6 Steam and power shovels
7
8
9
10
11 Depreciation

CA60-1 Miscellaneous Equipment

The above accounts require the submission of an annual inventory containing the physical assets of the Highway Commission, the value of the assets shown on the last inventory, depreciation or appreciation and the net value to date. The fiscal year ends the 30th day of June of each year.

CAPITAL ASSETS
PREFIX LETTER "CA"
SHOP STORES

CA55-10 Helena Shop stores

This account includes all Store items such as tires, tubes, shovels, hand tools, auto and truck parts, etc. When issued from stores, they are to be charged to the proper account and credit passed to this account; in the case of charges to construction force account and construction engineering, for the purpose of collecting Federal Aid, an itemized statement must accompany the charge.

CAPITAL ASSETS
DIVISION STORES ACCOUNT
PREFIX LETTER "CA"

CA56-1	Missoula
2	Great Falls
3	Billings
4	Wolf Point
5	Butte
6	Havre
7	Lewistown
8	Bozeman
9	Glendive
10	Helena
11	Kalispell
12	Miles City
13	
14	
15	

Suffixes

CA56-1-01	Grader Blades
02	Culvert pipe
03	Gasoline
04	Road oil

Inventory is required every thirty days. This inventory shall show quantities on hand, amount purchased during the month, amount distributed, and account to which the distribution shall be charged. Use Form 88.

SUNDRY ACCOUNTS

The following accounts are not to be used in the Field except on written authority from Headquarters.

S-61 Road Maps (G. L. Acct. 344)

S-62 Helena Office Stores

E-25-18 Scales, etc., for Border Inspection

AR-500, etc. Accounts Receivable (to be assigned on written authority from Helena office)

W. O. 1000, etc. Work Orders: to be used in conjunction with preconstruction, right of way and construction. When requesting a work order number, give full description of project and purpose for which the work order is desired. Written authority will be furnished from Headquarters.

CHAPTER X

PERSONNEL DEPARTMENT

10.1 Governing the Application of Standard Qualifications and Salaries.

10.11 General A Personnel Department has been organized by the State Highway Commission which will handle all employment of a technical, clerical and supervisory nature, interdivisional and interdepartmental transfers, and changes in classification. The objectives of this department are: (1) to classify all salaried employees and analyze their present responsibilities; (2) to receive and to rate all applications for employment; (3) to institute and maintain a complete personnel record and efficiency records of each salaried employee, and (4) to coordinate the man-power needs of the several Departments and Divisions consistent with the changing demands of our work. It is obvious that such a plan will secure many desirable results such as (1) relieving department and division heads of the annoyance of interviewing numberless applicants for employment; (2) protecting present employees by arranging advancements and transfers to fill vacancies from its own personnel if there be those in the Highway employ with proper qualifications, and (3) increasing the efficiency and morale of our organization by centralized and impartial performance records covering each responsible employee.

10.12 Development The acquirement of technical knowledge on the part of employees and the development of other qualifications, such as initiative, personality, and efficiency will be observed by your immediate Superior and will form the basis of recommendations for advancement, etc. Immediate Superiors are charged with the duty of developing their respective units to the highest possible degree of efficiency.

10.13 Exception The Personnel Department was organized since the publication of Manual of Instructions of Maintenance, second edition. Rules and procedure approved at a later date will supercede all previous rules and regulations in conflict.

10.14 General Qualifications The following general qualifications apply to all classified employees in Highway service and are to be considered a part of the qualifications for each individual grade and service:

A. Every employee must be of high moral character.

B. No one shall be employed who is suffering from any communicable disease.

C. All things being equal, preference shall be given to residents of Montana, and Veterans.

10.15 Initial Rate of Compensation The initial compensation of a Highway employee shall be the rate of compensation prescribed for the classified position to which he is appointed.

10.16 Prior Service Credit Service within a grade will include service prior to the adoption of this classification. Upon the approval of the Highway Engineer, former similar service in other than State employment may be accepted as partial prior service credit in Highway employment.

10.17 Promotions Promotions will be approved by the department head only for competent and faithful employees who have rendered superior service either in speed, accuracy, quality, reliability, fidelity, or character of their work, upon the recommendation of the responsible division or section chief. Length of service without improvement will not justify increase in pay or promotion. Maximum ability in a specific position should be developed and promotion may be achieved only by transfer to a position of a higher grade.

10.18 Vacancies Vacancy in any position in Highway employment will be filled, when practical, by transfer or promotion of a worthy and competent employee, from a lower grade.

10.19 Demotion Limits An employee transferred to a lower grade shall receive a salary not higher than the salary payable in accordance with the Schedule of Classification.

10.110 Reclassification of Positions Reclassification of positions may not be made for personal reasons and will be approved only upon the submittal of satisfactory evidence that through decided increase or decrease of duties or responsibilities

the relation of the position in its importance to the whole departmental organization has changed. When the relation of any position in its importance to the departmental organization as a whole has changed, because of a decided increase or decrease of duties or responsibilities, a job analysis form shall be prepared covering such positions, and the procedure set forth above, for the creation of positions, shall be followed.

The department shall be notified in writing that the position has been reclassified and a vacancy exists to be filled in accordance with the procedure for making appointments to positions.

Duties of a temporary nature which may be required of employees of a higher grade, unless known to be permanent, shall not be sufficient basis for classification into a higher grade. When the duties connected with a position have changed to a degree that the standard duties of that particular grade do not apply, it will become the duty of the department head to request a review and reclassification of the position.

10.111 Part Time Employment In case of employment on a part-time basis, the proper grade and service shall be determined and assigned to the position. The salary payable will be the proportion of the full salary which part time bears to the full time.

10.112 Hourly or Per Diem Rates Work for which payment is made on the hourly or per diem basis, is not covered by this classification. Employment requirements on a per diem basis must have the previous written approval of the Administrative office.

10.113 Enforcement The standard qualifications and salaries established shall be mandatory as to all employees of all departments, except the Administrative Heads.

10.114 Effective Date The standard qualifications and salaries established and the foregoing rules and regulations become effective upon approval.

10.115 Creation of Positions When it becomes necessary to create a position in any department resulting from:

New duties, activities, or functions added by law;

Expansion of present duties, functions, or activities the procedure shall be as follows:

1. The department shall secure a job analysis form covering the position created, showing:

General statement and assigned duties

Minimum qualifications for education, training, and experience.

Personal requirements.

2. The department shall then:

Secure approval of responsible supervisors and head of department.

Obtain a statement showing in detail the necessity for the creation of position.

Forward all the above to the Personnel Office.

3. The Personnel Office shall:

Classify the position as to grade and service in accordance with Classification Manual.

Secure the approval of the Personnel Director, Highway Engineer, Highway Commission and Board of Examiners.

Notify the department in writing that the position has been created and a vacancy exists, to be filled in accordance with procedure established for making appointments to positions.

10.116 Appointments to Positions Whenever a vacancy shall exist and the necessity for filling the position shall have been definitely determined, a request for appointment shall be sent from the division or section head to the Personnel Office which, after approval of the department head, shall be forwarded to the Administrative Office for Executive approval. (Note: See Personnel Request and Payroll Authorization Bulletins for detailed information.)

Selections shall be made from available lists of applicants sent to the department by the Personnel Office for attention.

10.117 Transfer of Employees To transfer an employee to another position of equal grade or promotion to one of higher grade, the reasons for the transfer shall be stated, proper forms filled in, and necessary approval secured, in a manner similar to that followed in making appointments.

10.118 Promotions or Demotions When an employee becomes entitled to a Change in Classification because of meritorious service, or a reduction in classification becomes necessary, the proper forms shall be forwarded to the Personnel Office for approval, in the same manner as outlined under appointments to positions.

10.119 Abolishing Positions If the duties of a position become unnecessary or can be absorbed in other positions, steps shall be taken for discontinuing such position by forwarding proper forms to the Personnel Office.

10.120 Dismissals In case of dismissals, the proper forms shall be forwarded to the Personnel Office and approval secured in the same manner followed for appointments.

10.121 Severance of Relations The Personnel Office shall be notified by use of proper forms in case of resignations or deaths.

10.122 Personnel Records Each division and the accounting department shall maintain a personnel card record of all permanent employees. A complete personnel record of employees covering all departments shall be maintained in the Personnel Office, and will be available to Department heads at headquarters. The personnel cards will serve as a basis for the field and office of the payrolls and the information thereon must substantiate the routine information contained in the Personnel Department records.

10.2 Classification of Employees and Uniform Wage Structure

Classification	Monthly Rate
Accountant	$ 275
Accountant, Assistant	200
Agent, Right of Way, Chief	250
Agent, Right of Way Chief Field	245
Agent, Right of Way	225
Attorney, Right of Way	300
Auditor, Contract Payroll Field-Adm.*	225
Axman, Construction	110
Axman, Locating	90
Bookkeeper, Sr.	175
Bookkeeper, Jr.	165
Blueprinter	125
Clerk, Sr.,—All Departments	150
Clerk, Junior—All Departments	135
Clerk, Contract & Federal Aid	140
Clerk, Division	150
Clerk, Division—Acting	135
Clerk, Equipment—Helena*	185
Clerk, Maintenance, Chief—Helena	160
Clerk, Receiving & Shipping	125
Clerk, Statistical—All Departments	125
Clerk, Stenographer—or Sr. Stenographer	125
Clerk, Testing, Chief—Helena	160
Chemist, Chief—Testing Department	175
Chemist, Chief, Ass't.—Testing Department	150
Chemist, Research—Testing Department	150
Chemist, Testing Department	140
Chemist, Field	135
Chainman, Construction	115
Chainman, Head	110
Chainman, Rear	100
Checker, Bridge	235
Checker, Bridge, Acting	215
Checker, Gravel	125
Checker, Gravel, Ass't.	115
Checker, Oil Field Laboratory	100
Checker,Oil Field	125

Classification	Monthly Rate
Computer	150
Computer, Acting	135
Designer, Bridge, Chief	300
Designer, Bridge, Chief, Acting	275
Designer, Bridge, Senior	250
Designer, Bridge, Junior	225
Designer, Bridge, Acting	215
Designer, Highway	200
Designer, Highway, Acting	175
Designer, Right of Way	175
Draftsman, Bridge, Senior	165
Draftsman, Locating, Field	120
Draftsman, Plans, Chief	250
Draftsman, Plans	160
Draftsman, Junior—All Departments	150
Draftsman, Right of Way	160
Draftsman, Tracer—All Departments	125
Draftsman, Tracer, Acting—All Departments	100
Detailer, Bridge, Senior	200
Detailer, Bridge, Junior	185
Detailer, Bridge, Acting	175
Director, Planning Survey*	
Director, Personnel Service*	
Distributor, Gasoline*	125
Engineer, Bridge, Design	350
Engineer, Bridge Design, Acting	325
Engineer, Bridge Construction	350
Engineer, Bridge Construction, Acting	300
Engineer, Bridge, Resident	250
Engineer, Bridge, Resident, Acting	225
Engineer, Bridge, Project	200
Engineer, Bridge, Project, Acting	175
Engineer, Bituminous, Assistant	250
Engineer, Bituminous, Assistant, Acting	225
Engineer, Bituminous, Project	200
Engineer, Bituminous, Project, Acting	175
Engineer, Division	300
Engineer, Division, Acting	275
Engineer, Locating	200
Engineer, Maintenance, Ass't.	275

Classification	Monthly Rate
Engineer, Maintenance, Resident	250
Engineer, Maintenance, Acting	225
Engineer, Office	300
Engineer, Office, Sr. Ass't.	250
Engineer, Office, Jr. Ass't.	200
Engineer, Project	200
Engineer, Project, Acting	175
Engineer, Plans	300
Engineer, Right of Way	250
Engineer, Testing	250
Engineer, Resident	250
Engineer, Resident, Acting	225
Engineer, Testing, Assistant	200
Engineer, State Highway*	
Engineer, State Highway, Assistant*	
Engineer, Bridge*	
Engineer, Mtce. and Bituminous*	
Engineer, Construction—Pre-Construction*	
Engineer, Assignments, Special*	
Engineer and Secretary, Administrative*	
Foreman, Sign*	175
Foreman, Gravel Crusher*	175
Foreman, Maintenance*	160
Foreman, Maintenance*	165
Foreman, Maintenance*	175
Foreman, Maintenance*	185
Foreman, Maintenance*	190
Foreman, Oil*	175
Foreman, Oil*	190
Foreman, Paint*	150
Foreman, Shop*	165
Foreman, Shop*	175
Foreman, Shop*	190
Foreman*	150
Instrument Man—All Departments	150
Instrument Man, Acting—All Departments	135
Inspector, Bridge	150
Inspector, Bridge, Acting	135
Inspector, Gravel	135
Inspector, Labor*	150
Inspector, Oil, Chief	150
Inspector, Oil	135

Classification	Monthly Rate
Laboratory, Assistant	125
Laboratory, Assistant, Acting	115
Messenger*	100
Mechanic, Division*	175
Mechanic, Division*	185
Mechanic, Division*	200
Mechanic, District*	150
Mechanic, District*	165
Mechanic, District*	175
Mechanic, Head, Auto*	190
Mechanic, Master*	225
Plotter—Plans	125
Procurement, Agent, Adm.	150
Rodman	125
Rodman, Acting	115
Stenographer, Senior	125
Stenographer, Junior	115
Sampler, Filer—Laboratory	110
Squad, Chief, Bridge	265
Squad, Chief, Bridge, Acting	250
Superintendent, Equipment*	250
State Park Authority*	200
Typist, Senior—All Departments	110
Typist, Junior—All Departments	100
Topographer	120
Truck Driver*	125
Truck Driver*	150
Watchman*	125
Watchman*	100

*Not Included in Previous Classification.

10.3 Personnel Request Form

10.31 Objective Personnel Request, Form No. 6, has a dual purpose, first, in making up engineering parties for new preconstruction and construction projects, or other new personnel requirements in a Department or Division, and second, to advise the Personnel Department in advance, of employees who will become available for transfer.

10.32 Tentative Assignments As an example of the first case, whenever a list of projects is announced for letting, the Personnel Office will immediately request from each appropriate Division Office a list of required personnel for each project, on Personnel Request, in triplicate. This will show not only the number of employees required, their classifications and salaries, but also the date they should report on the project and the probable duration of assignment. The Division Engineer will have in mind probably certain men in his division whom he would like to assign to certain projects. Such suggested arrangements are indicated under "Personnel Available for Transfer." Should it be felt by the Department or Division head that more than one project can be effectively handled by one party, it should be so stated under comments on the reverse side of the form, showing in each case, the additional projects. However, a form should be filed for each individual project. Other desired comments may be typed on the back of the sheet.

10.33 Control of Assignments The bottom bracket, "Assignments," will be filled out by the Personnel Department and an approved copy returned to the Department or Division Offices and a copy placed with the Construction Engineer. Except in special cases, it will be the policy to effect transfers within a Division where possible, rather than between Divisions.

10.34 Probable Duration The second use for Form will be to advise the Personnel Department of prospective termination of employment, the alternative to transfer being a furlough. In such cases the Department or Division will forward the form in triplicate, using the second

bracket only. This will receive immediate attention and the disposition to be made of such employees will be made known to the Department or Division head.

10.35 Statewide Application In order that our employees may be given every consideration, it is essential that changes in personnel requirements be anticipated as far in advance as possible and the information forwarded to Helena without delay. It is our objective to treat our organization as one Statewide unit, rather than a collection of more or less isolated and independent divisions and districts.

10.4 Payroll Authorization—Form 142

10.41 Objective Payroll authorizations or advice are required for securing proper authorizations for additions, transfers, changes in classification, rates of pay or release from payroll, **affecting only those employees embraced in classifications of employees and uniform wage structure.**

10.42 Procedure The procedure for any payroll change is as follows Immediately upon any addition or release, and prior thereto, if possible, or before any change is made in classification or rate, Payroll Authorization with complete detail for "Explanation or Reason" must be prepared in **triplicate,** and recommended for approval, by employee in responsible charge. **All three copies** are submitted to Department or Division head and then, if approved, transmitted to the Administrative Office for approval, disapproval or recommendation for further consideration. After final action by Administrative Office, the original is sent to the Accounting Department where it will govern the auditing of payrolls, a copy is filed with the Personnel Department and a copy is returned to the issuing Department or Division for appropriate actions. Additions or changes on payroll can only be made upon final approval if Payroll Authorization by Administrative Office.

10.43 Transfers The procedure for transfer of employee from one Division to another, or one Department to another, will be as above, with the addition of an extra copy to be made for Division or Department to which employee is transferred, showing the last day employee was carried on

payroll, also if transportation or other expenses are to be taken care of, etc. This copy should be forwarded **direct** to Division or Department (as advice of transfer) upon approval of Division or Department head. (Do not send this copy to Helena office.)

The procedure for intra-division transfers:

1. Whenever a transfer is made and there are no changes in classification or rate, and party will be carried on same payroll as before, no Payroll Authorization is required.
2. Transfers from one project to another, Payroll Authorizations are required—and in space explanation—**show project number from and to which transfer is made.**

10.44 Temporary Employees Under explanation, always show the length of time required to complete work.

10.45 Releases In case of release for cause of any employee, no formal approval in advance is required. However, a complete statement of the causes for such summary release should be given on the Payroll Authorization form, which should be forwarded immediately through the regular channels.

10.5 Personnel Forms—Application and Re-Employment Form No.....

Form No. 125 and Form No. 126

10.51 Scope All employees, who are on the payroll of the Highway Department, **(Employees as shown on Classifications of Employees and Uniform Wage Structure)** or may be added thereto, are required to file with Personnel Department, Form No. 125.

10.52 Applications All new employees when placed on payroll must file application. (If application is on file in Personnel Department and dated not more than six months from date of employment, this form will not be required.) For former highway employees who have been out of service more than **six** months the above forms are required.

10.53 Limits All personnel forms must be filed before payroll authorization can be approved.

10.54 Procedure Form No. 126 will be handled directly between employee and Personnel Department.

10.6 Leaves of Absence

10.61 Regular Leave Employees, before eligible to Regular Leave of Absence, twelve months of continuous service is required.

10.611 Extent Every employee during each calendar year is entitled to twelve days of absence with full pay. This leave of absence shall be known as the "Regular Annual Leave of Absence." In computing days absent, all days shall be counted as full days, except Sundays, legal holidays and other holidays declared by proper authority. The regular leave of absence shall be granted only for those periods when service will best permit and shall be staggered among the employees so as to cause the least inconvenience to the service. In no case shall leaves of absence with pay be granted to employees paid on an hourly, daily, or weekly basis.

10.612 Exceptions Employees who enter the service after the beginning of the calendar year shall be granted leave of absence with pay for a period equal to one day for each month in the service. Employees released for causes beyond their control, shall be entitled to leave of absense with pay on the basis of one day for each month from the beginning of the calendar year in which such release occurs.

10.62 Meritorious Leaves of Absence In special and meritorious cases, adtional leaves of absence with pay for not more than twelve days in any one calendar year may be granted to avoid peculiar hardship when an employee is required to be absent from work because of:

1. His or her illness.
2. Affliction of a member of the employee's immediate family with a serious illness which requires the employee's care and attention.
3. Contact or exposure to a contagious disease rendering the presence of the employee harmful to other State employees.
4. A death in the employee's immediate family.

Such leaves of absence shall be known as "meritorious leaves of absence." Absence of an employee for any one of the above reasons shall be computed as part of his regular leave of absence unless in the opinion of the department head, the employee should have special consideration because of meritorious service.

10.621 Exceptions Slight ailments or indisposition shall not be accepted as sufficient cause for meritorious leave of absence. Illness during an employees regular leave of absence shall not be permitted to extend such absence unless a meritorious leave of absence is approved previous to the date set for the return of the employee to work. Employees shall be held to strict accountability for the statements made by them concerning leaves of absence. Any misrepresentation shall subject the employee to disciplinary action.

10.622 Extent The number of days of meritorious leaves of absence shall be computed in the same manner as regular leave of absence. All other days absence of employees from regular duty, shall be computed as part of his regular leave of absence.

10.63 Total Leave No employee shall be granted a leave of absence with pay beyond twenty four (24) days in any one calendar year without the approval of the Highway Engineer. Each employee shall be entitled to his regular leave of absence only in the calendar year in which it accrues and in no case shall the regular leave of absence to which he is entitled in any one year, be added to his regular leave of absence for any succeeding year.

10.64 Holidays

New Year's	Jan. 1st.
Lincoln's Birthday	Feb. 12th
Washingtons Birthday	Feb. 22nd
Memorial Day	May 30th
Independence Day	July 4th
Labor Day	1st Monday in Sept.
Columbus Day	October 12th
Armistice Day	November 11th
Thanksgiving Day	Last Thursday in Nov.
Christmas Day	December 25th

10.7 Rating and Merit System

10.71 To Expand the Application It will be noted in the following we have used the word "Engineer" but for departments other than the Engineering, the word "Clerk," "Accountant," "Foreman," etc. can be substituted.

10.72 Scope The rating schedule indicates the classification and also shows the method of grading employees. The total of the employee's merit card plus one point allowed for each complete year's Highway service constitutes the employee's seniority rating. The names of all employees are then arranged in order of their seniority within their particular classification and these lists form the basis for promotions, layoffs and other changes in Personnel. For instance, the construction program in some divisions may be reduced to such an extent that it becomes necessary to lay off a Project Engineer. Instead of arbitrarily laying off this man, the Division Engineer notifies the Personnel Office of the situation in his district. The Personnel Officer may have been informed by some other Division Engineer or Department head that he could use an additional Project Engineer and is, therefore, able to arrange for the transfer. If, on the other hand, no place can be found for the Project Engineer from the first mentioned District, the Personnel Office determines from the seniority list which Project Engineer has the lowest seniority rating and this man is laid off regardless of the particular division in which he is working. The result is that the most valuable men are retained regardless of conditions in the particular division in which they are working. In other words, Division lines are broken down in favor of the welfare of the department as a whole. The man with the lowest seniority rating, in lieu of being laid off, may be offered employment in a lower classification, in which case the same method is followed in making room for him in the lower classification.

10.73 Requests and Procedure When in need of additional help, a Division or Department head makes a request to the Headquarters Office and the Personnel Officer forwards to him the name or names of the highest men on the waiting list, for that particular classification, with a

brief description of the qualifications and experience. The Division Engineer or Department Head is at liberty to select from these names the one whom he feels will best fit his needs. The man thus selected may be a former employee, an applicant who has not, as yet, had service with the Highway Department or a man now in our employ who is ready for promotion.

10.74 Extent All information regarding employees is recorded on the employee's service record card, marked "F", which is kept in a record case. This matter is considered confidential and only the Chief Highway Engineer and the Personnel Officer have access to its code. Colored flag signals attached to the top of these Personnel record cards indicate the classification of the employee and the coloring shown in the blocks at the top of the card gives us ready visual indication of the employees experience along different lines. Every change in position, salary, character of work is noted on these cards.

10.75 Severance When an employee has severed his connection with the Highway Department, his card is removed from the card file and filed. This gives us a complete record at all times, not only of our present employees, but of the past personal service employees.

10.76 Applications for Employment Applications received in the Division and Department offices are forwarded to the Personnel office at Headquarters. These are submitted on a standard application form which we have marked "C". When received, the Personnel Officer examines the application and, if the applicant has had previous experience, he communicates with the applicant's former employers and forwards them questionnaire form which we have marked "D". Upon the return of this form, the Personnel Officer is able, from the data thus secured, to assign a tentative rating to the applicant and his name is placed on the eligible waiting list in order of seniority. The Personnel Office will arrange to keep applications up to date by forwarding to applicant at stated periods, a form to determine if he is still available. We have marked this form "E".

10.77 Rating The actual rating of an employee as to education and experience will be taken direct from his personal history card. (By the Personnel Department.)

On form marked "B", the employee is first rated by his immediate superior (in most cases it being Project Engineer and Resident Engineer) and rating is shown in Column 1. These grades are subject to review by the Division Engineer or Department head who indicates his estimate of the employee in Column 2. The rating sheet is then forwarded to the Personnel Office and the final rating is made and entered in Column 3. Men at the head of the seniority list, if deemed eligible, are also given tentative rating for the promotion to the next higher classification. This record, marked "F", having a flagged position, will enable us to list them for employment in the next higher classification. By use of flags we have provided for a waiting list for promotions to the higher classifications. In grading an employee under the five personal qualification points, our dependence is placed on the previous knowledge of the employee by his immediate superior. One thing, however, should be borne in mind; namely, that it is rather unusual to find an employee who will be considered as exceptional and therefore entitled to eight points in all of the personal qualifications.

10.771 Procedure We are outlining briefly just what should be used under each of the five personal qualifications.

(a) Initiative

By this is meant the employee's resourcefulness, aggressiveness, adaptability and constructive thinking. Is he capable of using all his technical knowledge or does he have to depend on his Superior's advise in all but purely routine work? Is he adept in planning his work?

(b) Personality

Under the head of personality should be considered the employee's personal appearance, ability to contact the public and his personal attitude. There should also be considered in this connection the employee's ability to get along harmoniously and at the same time to inspire confidence and respect among his fellow workers, contractors and the public.

(c) Skill

One can consider the employee's skill as his ability to perform the tasks required of the particular classification to which he belongs and upon which he is

being graded, information as to his technical knowledge, familiarity with standards, accuracy, speed and neatness and specialized knowledge and ability in his particular line of work. A particular specialized knowledge of all branches of his work should not be essential for a satisfactory or even an exceptional rating. For example, a Project Engineer may have comparatively little experience in paving or bridge work but he is exceptionally successful on location and grading work. If the handling of his work is such as to warrant the assurance that he would, with reasonable experience, develop a high degree of efficiency in other lines, he would be entitled to a good rating in spite of the fact that his experience has largely been confined to special phases of the work.

(d) Judgment

By judgment is meant the ability to thoroughly grasp the situation and draw the correct conclusions. Does the employee profit by experience? Does he evidence a proper understanding of proportions, relative values and discretion, not only regarding his actual work but in other contacts with his associates and the public?

(e) Integrity

By integrity we mean truthfulness, dependability and promptness in meeting obligations. Loyalty to his superiors and to the department should also be considered in rating the employee under this heading.

10.78 Conclusion With the above outline, the employee's immediate superior should have no difficulty in efficiency rating on the five personal qualifications.

APPENDIX

STATE HIGHWAY COMMISSION PRINTED FORMS

Form No.	Article
1	Long Distance Telephone Call Record—100 Sheets to a pad.
2	Emergency Field Purchase Order Book—25 Sets to a book.
3	Personnel Card.
4	Interdepartmental Memo—100 sheets to a pad.
5	Correspondence Book—25 sets to a book.
12	Extra Work Order.
13	Additional Work.
14	Progress Estimate.
16	Computation Sheets.
16A	Coordinate Sheets.
17	Summary Sheets.
19	Application Blank.
21	Weekly Oil Report—50 sets to a pad.
22	Daily Oil Report (State Forces)—50 sets to a pad.
23	Claim Blanks—25 sets to a pad.
25	Shipping Tags—Return Address—Wired.
26	Columbia Clasp Envelope, No. 75—Gummed.
27	Columbia Clasp Envelope No. 97—Gummed.
30	Right of Way Easement.
31	Payroll—10 sets to pad.
32	General Information Sheet—R/W.
33	Right of Way Option to Purchase (Descriptive Sheet).
34	Right of Way Descriptive Sheet (Duplicate).
35	Right of Way Rough Descriptive Sheet.
37	Right of Way Grant of Possession.
38	Right of Way Partial Release of Mortgage.
39	Right of Way Joint Fencing Agreement.
40	Right of Way Second Notices—on penny postcard.
42	Right of Way Current Status Report.
46	Stock Requisition—50 sheets to a pad.
47	Report on Sample of Gravel—25 sets to a pad.
52	Equipment Inventory—in triplicate—25 sets to a pad.
61	Traffic Census—50 sets to a pad.
62	Daily Weather Report—25 sets to a pad.

Form No.	Article
63	Extension of Time for Unloading Cars—25 sets to a pad.
66	Cross-Section Paper—yellow.
76	Equipment Department Requisition—25 sets to a pad.
88	Annual Inventory Sheet.
89	Equipment Transfer Report.
90	Equipment Service Record.
92	Pit Report—Laboratory Form No. 1.
93	Forms to Accompany Compression Specimens Made in Field—Laboratory Form No. 4.
94	Test Results—Laboratory Form No. 5.
95	Notice of Pre-tested Cement Shipment—Laboratory Form No. 8.
96	Aggregate and Proposed Surfacing—Laboratory Form No. 17.
97	Form to Accompany Sample of Top or Base Course Surfacing After Pit Has Been Approved—Laboratory Form No. 26.
98	Report on Sample of Oil Mix ( ) Dry Mix ( ) —Laboratory Form No. 27.
99	Reporting Top Course and Base Course Surfacing After Pit Has Been Approved —Laboratory Form No. 28.
100	Gasoline Report Sheet—Lab. Form No. 30.
101	Road Oil Report Sheet—Lab. Form No. 13.
102	Report on Sample of Metal Pipe—Laboratory Form No. 3.
103	Road Oil Acceptance Certificate—50 sets to a book.
104	Aggregate Chart.
110	Survey Progress Report.
113	Equipment on Construction Mileage Record—Daily, 25 sets to a book.
116	Car Received Ticket—25 sets to a book.
122	Drive Safely Card.
124	Scale Ticket—In Triplicate—50 sets to a book.
125	Personal History Statement—25 sets to a pad.
126	Personnel and Duty Chart—25 sets to a pad.
133	Section 3374 R. C. M. 1921—Right of Way.
134	Fencing Policy Notice, Right of Way.
139	Conditional Release.
140	Personal History Record—two sides—Buff.
141	Personal History Record—one side—White.
142	Payroll Authorization.

Mimeographed Forms—1936

1	Construction Employment Report—for Division Labor Insp.
2	Monthly Report Covering State Sponsored W. P. A. Projects.
3	Progress Report.
4	Equipment Rental.
6	Personnel Request.
Emp. 24	U. S. Dept. Agr. Bureau Public Roads—Weekly Payroll Project Summary (Stencil No. 21) for Works Program and F. A. P.

LABORATORY FORMS

(No S. H. C. Number)

Form No.	Article
2	To Accompany Culvert Pipe Samples.
3	Report on Samples of Culvert Pipe.
6	Method of Making and Storing Concrete Cylinders.
7	Method of Testing for Consistency of Portland Cement Concrete.
9	High Carbon Tar, Hot Application.
10	Low Carbon Tar, Cold Application.
11	Creosote Oil.
12	Request for Materials.
14	Report on Samples of Reinforcing Steel.
15	Sample Request for Job.
16	To Accompany Cement Samples.
18	Laboratory Receiving Sheet.
19	Report on Samples of Concrete Pipe.
23	Report on Inspection of Woven Slat Snow Fence.
24	Test for Asphalt Content, Revised, October, 1932.
25	Corrugated Metal Pipe Test Sheet.
29	Standard Definitions of Terms Relating to Materials for Roads and Pavements.
34	Form to Accompany Gasoline Samples Submitted for Testing.
35	Field Test Reports on Road Oils.

30 DAY MONTH 30

TABLE OF AMOUNTS EARNED AT VARIOUS MONTHLY RATES

Days	Amount Earned at Different Rates																Days
	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00	105.00	110.00	115.00	
1	1.33	1.50	1.67	1.83	2.00	2.17	2.33	2.50	2.67	2.83	3.00	3.17	3.33	3.50	3.67	3.83	1
2	2.67	3.00	3.33	3.67	4.00	4.33	4.67	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67	2
3	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00	10.50	11.00	11.50	3
4	5.33	6.00	6.67	7.33	8.00	8.67	9.33	10.00	10.67	11.33	12.00	12.67	13.33	14.00	14.67	15.33	4
5	6.67	7.50	8.33	9.17	10.00	10.83	11.67	12.50	13.33	14.17	15.00	15.83	16.67	17.50	18.33	19.17	5
6	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	6
7	9.33	10.50	11.67	12.83	14.00	15.17	16.33	17.50	18.67	19.83	21.00	22.17	23.33	24.50	25.67	26.83	7
8	10.67	12.00	13.33	14.67	16.00	17.33	18.67	20.00	21.33	22.67	24.00	25.33	26.67	28.00	29.33	30.67	8
9	12.00	13.50	15.00	16.50	18.00	19.50	21.00	22.50	24.00	25.50	27.00	28.50	30.00	31.50	33.00	34.50	9
10	13.33	15.00	16.67	18.33	20.00	21.67	23.33	25.00	26.67	28.33	30.00	31.67	33.33	35.00	36.67	38.33	10
11	14.67	16.50	18.33	20.17	22.00	23.83	25.67	27.50	29.33	31.17	33.00	34.83	36.67	38.50	40.33	42.17	11
12	16.00	18.00	20.00	22.00	24.00	26.00	28.00	30.00	32.00	34.00	36.00	38.00	40.00	42.00	44.00	46.00	12
13	17.33	19.50	21.67	23.83	26.00	28.17	30.33	32.50	34.67	36.83	39.00	41.17	43.33	45.50	47.67	49.83	13
14	18.67	21.00	23.33	25.67	28.00	30.33	32.67	35.00	37.33	39.67	42.00	44.33	46.67	49.00	51.33	53.67	14
15	20.00	22.50	25.00	27.50	30.00	32.50	35.00	37.50	40.00	42.50	45.00	47.50	50.00	52.50	55.00	57.50	15
16	21.33	24.00	26.67	29.33	32.00	34.67	37.33	40.00	42.67	45.33	48.00	50.67	53.33	56.00	58.67	61.33	16
17	22.67	25.50	28.33	31.17	34.00	36.83	39.67	42.50	45.33	48.17	51.00	53.83	56.67	59.50	62.33	65.17	17
18	24.00	27.00	30.00	33.00	36.00	39.00	42.00	45.00	48.00	51.00	54.00	57.00	60.00	63.00	66.00	69.00	18
19	25.33	28.50	31.67	34.83	38.00	41.17	44.33	47.50	50.67	53.83	57.00	60.17	63.33	66.50	69.67	72.83	19
20	26.67	30.00	33.33	36.67	40.00	43.33	46.67	50.00	53.33	56.67	60.00	63.33	66.67	70.00	73.33	76.67	20
21	28.00	31.50	35.00	38.50	42.00	45.50	49.00	52.50	56.00	59.50	63.00	66.50	70.00	73.50	77.00	80.50	21
22	29.33	33.00	36.67	40.33	44.00	47.67	51.33	55.00	58.67	62.33	66.00	69.67	73.33	77.00	80.67	84.33	22
23	30.67	34.50	38.33	42.17	46.00	49.83	53.67	57.50	61.33	65.17	69.00	72.83	76.67	80.50	84.33	88.17	23
24	32.00	36.00	40.00	44.00	48.00	52.00	56.00	60.00	64.00	68.00	72.00	76.00	80.00	84.00	88.00	92.00	24
25	33.33	37.50	41.67	45.83	50.00	54.17	58.33	62.50	66.67	70.83	75.00	79.17	83.33	87.50	91.67	95.83	25
26	34.67	39.00	43.33	47.67	52.00	56.33	60.67	65.00	69.33	73.67	78.00	82.33	86.67	91.00	95.33	99.67	26
27	36.00	40.50	45.00	49.50	54.00	58.50	63.00	67.50	72.00	76.50	81.00	85.50	90.00	94.50	99.00	103.50	27
28	37.33	42.00	46.67	51.33	56.00	60.67	65.33	70.00	74.67	79.33	84.00	88.67	93.33	98.00	102.67	107.33	28
29	38.67	43.50	48.33	53.17	58.00	62.83	67.67	72.50	77.33	82.17	87.00	91.83	96.67	101.50	106.33	111.17	29
30	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00	105.00	110.00	115.00	30

30 DAY MONTH 30
TABLE OF AMOUNTS EARNED AT VARIOUS MONTHLY RATES

Days	Amount Earned at Different Rates															Days
	120.00	125.00	130.00	135.00	140.00	145.00	150.00	155.00	160.00	165.00	170.00	175.00	180.00	185.00	190.00	
1	4.00	4.17	4.33	4.50	4.67	4.83	5.00	5.17	5.33	5.50	5.67	5.83	6.00	6.17	6.33	1
2	8.00	8.33	8.67	9.00	9.33	9.67	10.00	10.33	10.67	11.00	11.33	11.67	12.00	12.33	12.67	2
3	12.00	12.50	13.00	13.50	14.00	14.50	15.00	15.50	16.00	16.50	17.00	17.50	18.00	18.50	19.00	3
4	16.00	16.67	17.33	18.00	18.67	19.33	20.00	20.67	21.33	22.00	22.67	23.33	24.00	24.67	25.33	4
5	20.00	20.83	21.67	22.50	23.33	24.17	25.00	25.83	26.67	27.50	28.33	29.17	30.00	30.83	31.67	5
6	24.00	25.00	26.00	27.00	28.00	29.00	30.00	31.00	32.00	33.00	34.00	35.00	36.00	37.00	38.00	6
7	28.00	29.17	30.33	31.50	32.67	33.83	35.00	36.17	37.33	38.50	39.67	40.83	42.00	43.17	44.33	7
8	32.00	33.33	34.67	36.00	37.33	38.67	40.00	41.33	42.67	44.00	45.33	46.67	48.00	49.33	50.67	8
9	36.00	37.50	39.00	40.50	42.00	43.50	45.00	46.50	48.00	49.50	51.00	52.50	54.00	55.50	57.00	9
10	40.00	41.67	43.33	45.00	46.67	48.33	50.00	51.67	53.33	55.00	56.67	58.33	60.00	61.67	63.33	10
11	44.00	45.83	47.67	49.50	51.33	53.17	55.00	56.83	58.67	60.50	62.33	64.17	66.00	67.83	69.67	11
12	48.00	50.00	52.00	54.00	56.00	58.00	60.00	62.00	64.00	66.00	68.00	70.00	72.00	74.00	76.00	12
13	52.00	54.17	56.33	58.50	60.67	62.83	65.00	67.17	69.33	71.50	73.67	75.83	78.00	80.17	82.33	13
14	56.00	58.33	60.67	63.00	65.33	67.67	70.00	72.33	74.67	77.00	79.33	81.67	84.00	86.33	88.67	14
15	60.00	62.50	65.00	67.50	70.00	72.50	75.00	77.50	80.00	82.50	85.00	87.50	90.00	92.50	95.00	15
16	64.00	66.67	69.33	72.00	74.67	77.33	80.00	82.67	85.33	88.00	90.67	93.33	96.00	98.67	101.33	16
17	68.00	70.83	73.67	76.50	79.33	82.17	85.00	87.83	90.67	93.50	96.33	99.17	102.00	104.83	107.67	17
18	72.00	75.00	78.00	81.00	84.00	87.00	90.00	93.00	96.00	99.00	102.00	105.00	108.00	111.00	114.00	18
19	76.00	79.17	82.33	85.50	88.67	91.83	95.00	98.17	101.33	104.50	107.67	110.83	114.00	117.17	120.33	19
20	80.00	83.33	86.67	90.00	93.33	96.67	100.00	103.33	106.67	110.00	113.33	116.67	120.00	123.33	126.67	20
21	84.00	87.50	91.00	94.50	98.00	101.50	105.00	108.50	112.00	115.50	119.00	122.50	126.00	129.50	133.00	21
22	88.00	91.67	95.33	99.00	102.67	106.33	110.00	113.67	117.33	121.00	124.67	128.33	132.00	135.67	139.33	22
23	92.00	95.83	99.67	103.50	107.33	111.17	115.00	118.83	122.67	126.50	130.33	134.17	138.00	141.83	145.67	23
24	96.00	100.00	104.00	108.00	112.00	116.00	120.00	124.00	128.00	132.00	136.00	140.00	144.00	148.00	152.00	24
25	100.00	104.17	108.33	112.50	116.67	120.83	125.00	129.17	133.33	137.50	141.67	145.83	150.00	154.17	158.33	25
26	104.00	108.33	112.67	117.00	121.33	125.67	130.00	134.33	138.67	143.00	147.33	151.67	156.00	160.33	164.67	26
27	108.00	112.50	117.00	121.50	126.00	130.50	135.00	139.50	144.00	148.50	153.00	157.50	162.00	166.50	171.00	27
28	112.00	116.67	121.33	126.00	130.67	135.33	140.00	144.67	149.33	154.00	158.67	163.33	168.00	172.67	177.33	28
29	116.00	120.83	125.67	130.50	135.33	140.17	145.00	149.83	154.67	159.50	164.33	169.17	174.00	178.83	183.67	29
30	120.00	125.00	130.00	135.00	140.00	145.00	150.00	155.00	160.00	165.00	170.00	175.00	180.00	185.00	190.00	30

30 DAY MONTH 30

TABLE OF AMOUNTS EARNED AT VARIOUS MONTHLY RATES

Days	Amount Earned at Different Rates															Days
	195.00	200.00	205.00	210.00	215.00	220.00	225.00	230.00	235.00	240.00	245.00	250.00	275.00	300.00	325.00	
1	6.50	6.67	6.83	7.00	7.17	7.33	7.50	7.67	7.83	8.00	8.17	8.33	9.17	10.00	10.83	1
2	13.00	13.33	13.67	14.00	14.33	14.67	15.00	15.33	15.67	16.00	16.33	16.67	18.33	20.00	21.67	2
3	19.50	20.00	20.50	21.00	21.50	22.00	22.50	23.00	23.50	24.00	24.50	25.00	27.50	30.00	32.50	3
4	26.00	26.67	27.33	28.00	28.67	29.33	30.00	30.67	31.33	32.00	32.67	33.33	36.67	40.00	43.33	4
5	32.50	33.33	34.17	35.00	35.83	36.67	37.50	38.33	39.17	4000	40.83	41.67	45.83	50.00	54.17	5
6	39.00	40.00	41.00	42.00	43.00	44.00	45.00	46.00	47.00	48.00	49.00	50.00	55.00	60.00	65.00	6
7	45.50	46.67	47.83	49.00	50.17	51.33	52.50	53.67	54.83	56.00	57.17	58.33	64.17	70.00	75.83	7
8	52.00	53.33	54.67	56.00	57.33	58.67	60.00	61.33	62.67	64.00	65.33	66.67	73.33	80.00	86.67	8
9	58.50	60.00	61.50	63.00	64.50	66.00	67.50	69.00	70.50	72.00	73.50	75.00	82.50	90.00	97.50	9
10	65.00	66.67	68.33	70.00	71.67	73.33	75.00	76.67	78.33	80.00	81.67	83.33	91.67	100.00	108.33	10
11	71.50	73.33	75.17	77.00	78.83	80.67	82.50	84.33	86.17	88.00	89.83	91.67	100.83	110.00	119.17	11
12	78.00	80.00	82.00	84.00	86.00	88.00	90.00	92.00	94.00	96.00	98.00	100.00	110.00	120.00	130.00	12
13	84.50	86.67	88.83	91.00	93.17	95.33	97.50	99.67	101.83	104.00	106.17	108.33	119.17	130.00	140.83	13
14	91.00	93.33	95.67	98.00	100.33	102.67	105.00	107.33	109.67	112.00	114.33	116.67	128.33	140.00	151.67	14
15	97.50	100.00	102.50	105.00	107.50	110.00	112.50	115.00	117.50	120.00	122.50	125.00	137.50	150.00	162.50	15
16	104.00	106.67	109.33	112.00	114.67	117.33	120.00	122.67	125.33	128.00	130.67	133.33	146.67	160.00	173.33	16
17	110.50	113.33	116.17	119.00	121.83	124.67	127.50	130.33	133.17	136.00	138.83	141.67	155.83	170.00	184.17	17
18	117.00	120.00	123.00	126.00	129.00	132.00	135.00	138.00	141.00	144.00	147.00	150.00	165.00	180.00	195.00	18
19	123.50	126.67	129.83	133.00	136.17	139.33	142.50	145.67	148.83	152.00	155.17	158.33	174.17	190.00	205.83	19
20	130.00	133.33	136.67	140.00	143.33	146.67	150.00	153.33	156.67	160.00	163.33	166.67	183.33	200.00	216.67	20
21	136.50	140.00	143.50	147.00	150.50	154.00	157.50	161.00	164.50	168.00	171.50	175.00	192.50	210.00	227.50	21
22	143.00	146.67	150.33	154.00	157.67	161.33	165.00	168.67	172.33	176.00	179.67	183.33	201.67	220.00	238.33	22
23	149.50	153.33	157.17	161.00	164.83	168.67	172.50	176.33	180.17	184.00	187.83	191.67	210.83	230.00	249.17	23
24	156.00	160.00	164.00	168.00	172.00	176.00	180.00	184.00	188.00	192.00	196.00	200.00	220.00	240.00	260.00	24
25	162.50	166.67	170.83	175.00	179.17	183.33	187.50	191.67	195.83	200.00	204.17	208.33	229.17	250.00	270.83	25
26	169.00	173.33	177.67	182.00	186.33	190.67	195.00	199.33	203.67	208.00	212.33	216.67	238.33	260.00	281.67	26
27	175.50	180.00	184.50	189.00	193.50	198.00	202.50	207.00	211.50	216.00	220.50	225.00	247.50	270.00	292.50	27
28	182.00	186.67	191.33	196.00	200.67	205.33	210.00	214.67	219.33	224.00	228.67	233.33	256.67	280.00	303.33	28
29	188.50	193.33	198.17	203.00	207.83	212.67	217.50	222.33	227.17	232.00	236.83	241.67	265.83	290.00	314.17	29
30	195.00	200.00	205.00	210.00	215.00	220.00	225.00	230.00	235.00	240.00	245.00	250.00	275.00	300.00	325.00	30

31 DAY MONTH 31

TABLE OF AMOUNTS EARNED AT VARIOUS MONTHLY RATES

Days	Amount Earned at Different Rates																Days
	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00	105.00	110.00	115.00	
1	1.29	1.45	1.61	1.77	1.94	2.10	2.26	2.42	2.58	2.74	2.90	3.06	3.23	3.39	3.55	3.71	1
2	2.58	2.90	3.23	3.55	3.87	4.19	4.52	4.84	5.16	5.48	5.81	6.13	6.45	6.77	7.10	7.42	2
3	3.87	4.35	4.84	5.32	5.81	6.29	6.77	7.26	7.74	8.23	8.71	9.19	9.68	10.16	10.65	11.13	3
4	5.16	5.81	6.45	7.10	7.74	8.39	9.03	9.68	10.32	10.97	11.61	12.26	12.90	13.55	14.19	14.84	4
5	6.45	7.26	8.06	8.87	9.68	10.48	11.29	12.10	12.90	13.71	14.52	15.32	16.13	16.94	17.74	18.55	5
6	7.74	8.71	9.68	10.65	11.61	12.58	13.55	14.52	15.48	16.45	17.42	18.39	19.35	20.32	21.29	22.26	6
7	9.03	10.16	11.29	12.42	13.55	14.68	15.81	16.94	18.06	19.19	20.32	21.45	22.58	23.71	24.84	25.97	7
8	10.32	11.61	12.90	14.19	15.48	16.77	18.06	19.35	20.65	21.94	23.23	24.52	25.81	27.10	28.39	29.68	8
9	11.61	13.06	14.52	15.97	17.42	18.87	20.32	21.77	23.23	24.68	26.13	27.58	29.03	30.48	31.94	33.39	9
10	12.90	14.52	16.13	17.74	19.35	20.97	22.58	24.19	25.81	27.42	29.03	30.65	32.26	33.87	35.48	37.10	10
11	14.19	15.97	17.74	19.52	21.29	23.06	24.84	26.61	28.39	30.16	31.94	33.71	35.48	37.26	39.03	40.81	11
12	15.48	17.42	19.35	21.29	23.23	25.16	27.10	29.03	30.97	32.90	34.84	36.77	38.71	40.65	42.58	44.52	12
13	16.77	18.87	20.97	23.06	25.16	27.26	29.35	31.45	33.55	35.65	37.74	39.84	41.94	44.03	46.13	48.23	13
14	18.06	20.32	22.58	24.84	27.10	29.35	31.61	33.87	36.13	38.39	40.65	42.90	45.16	47.42	49.68	51.94	14
15	19.35	21.77	24.19	26.61	29.03	31.45	33.87	36.29	38.71	41.13	43.55	45.97	48.39	50.81	53.23	55.65	15
16	20.65	23.23	25.81	28.39	30.97	33.55	36.13	38.71	41.29	43.87	46.45	49.03	51.61	54.19	56.77	59.35	16
17	21.94	24.68	27.42	30.16	32.90	35.65	38.39	41.13	43.87	46.61	49.35	52.10	54.84	57.58	60.32	63.06	17
18	23.23	26.13	29.03	31.94	34.84	37.74	40.65	43.55	46.45	49.35	52.26	55.16	58.06	60.97	63.87	66.77	18
19	24.52	27.58	30.65	33.71	36.77	39.84	42.90	45.97	49.03	52.10	55.16	58.23	61.29	64.35	67.42	70.48	19
20	25.81	29.03	32.26	35.48	38.71	41.94	45.16	48.39	51.61	54.84	58.06	61.29	64.52	67.74	70.97	74.19	20
21	27.10	30.48	33.87	37.26	40.65	44.03	47.42	50.81	54.19	57.58	60.97	64.35	67.74	71.13	74.52	77.90	21
22	28.39	31.94	35.48	39.03	42.58	46.13	49.68	53.23	56.77	60.32	63.87	67.42	70.97	74.52	78.06	81.61	22
23	29.68	33.39	37.10	40.81	44.52	48.23	51.94	55.65	59.35	63.06	66.77	70.48	74.19	77.90	81.61	85.32	23
24	30.97	34.84	38.71	42.58	46.45	50.32	54.19	58.06	61.94	65.81	69.68	73.55	77.42	81.29	85.16	89.03	24
25	32.26	36.29	40.32	44.35	48.39	52.42	56.45	60.48	64.52	68.55	72.58	76.61	80.65	84.68	88.71	92.74	25
26	33.55	37.74	41.94	46.13	50.32	54.52	58.71	62.90	67.10	71.29	75.48	79.68	83.87	88.06	92.26	96.45	26
27	34.84	39.19	43.55	47.90	52.26	56.61	60.97	65.32	69.68	74.03	78.39	82.74	87.10	91.45	95.81	100.16	27
28	36.13	40.65	45.16	49.68	54.19	58.71	63.23	67.74	72.26	76.77	81.29	85.81	90.32	94.84	99.35	103.87	28
29	37.42	42.10	46.77	51.45	56.13	60.81	65.48	70.16	74.84	79.52	84.19	88.87	93.55	98.23	102.90	107.58	29
30	38.71	43.55	48.39	53.23	58.06	62.90	67.74	72.58	77.42	82.26	87.10	91.94	96.77	101.61	106.45	111.29	30
31	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00	105.00	110.00	115.00	31

31 DAY MONTH 31

TABLE OF AMOUNTS EARNED AT VARIOUS MONTHLY RATES

Days	Amount Earned at Different Rates															Days
	120.00	125.00	130.00	135.00	140.00	145.00	150.00	155.00	160.00	165.00	170.00	175.00	180.00	185.00	190.00	
1	3.87	4.03	4.19	4.35	4.52	4.68	4.84	5.00	5.16	5.32	5.48	5.65	5.81	5.97	6.13	1
2	7.74	8.06	8.39	8.71	9.03	9.35	9.68	10.00	10.32	10.65	10.97	11.29	11.61	11.94	12.26	2
3	11.61	12.10	12.58	13.06	13.55	14.03	14.52	15.00	15.48	15.97	16.45	16.94	17.42	17.90	18.39	3
4	15.48	16.13	16.77	17.42	18.06	18.71	19.35	20.00	20.65	21.29	21.94	22.58	23.23	23.87	24.52	4
5	19.35	20.16	20.97	21.77	22.58	23.39	24.19	25.00	25.81	26.61	27.42	28.23	29.03	29.84	30.65	5
6	23.23	24.19	25.16	26.13	27.10	28.06	29.03	30.00	30.97	31.94	32.90	33.87	34.84	35.81	36.77	6
7	27.10	28.23	29.35	30.48	31.61	32.74	33.87	35.00	36.13	37.26	38.39	39.52	40.65	41.77	42.90	7
8	30.97	32.26	33.55	34.84	36.13	37.42	38.71	40.00	41.29	42.58	43.87	45.16	46.45	47.74	49.03	8
9	34.84	36.29	37.74	39.19	40.65	42.10	43.55	45.00	46.45	47.90	49.35	50.81	52.26	53.71	55.16	9
10	38.71	40.32	41.94	43.55	45.16	46.77	48.39	50.00	51.61	53.23	54.84	56.45	58.06	59.68	61.29	10
11	42.58	44.35	46.13	47.90	49.68	51.45	53.23	55.00	56.77	58.55	60.32	62.10	63.87	65.65	67.42	11
12	46.45	48.39	50.32	52.26	54.19	56.13	58.06	60.00	61.94	63.87	65.81	67.74	69.68	71.61	73.55	12
13	50.32	52.42	54.52	56.61	58.71	60.81	62.90	65.00	67.10	69.19	71.29	73.39	75.48	77.58	79.68	13
14	54.19	56.45	58.71	60.97	63.23	65.48	67.74	70.00	72.26	74.52	76.77	79.03	81.29	83.55	85.81	14
15	58.06	60.48	62.90	65.32	67.74	70.16	72.58	75.00	77.42	79.84	82.26	84.68	87.10	89.52	91.94	15
16	61.94	64.52	67.10	69.68	72.26	74.84	77.42	80.00	82.58	85.16	87.74	90.32	92.90	95.48	98.06	16
17	65.81	68.55	71.29	74.03	76.77	79.52	82.26	85.00	87.74	90.48	93.23	95.97	98.71	101.45	104.19	17
18	69.68	72.58	75.48	78.39	81.29	84.19	87.10	90.00	92.90	95.81	98.71	101.61	104.52	107.42	110.32	18
19	73.55	76.61	79.68	82.74	85.81	88.87	91.94	95.00	98.06	101.13	104.19	107.26	110.32	113.39	116.45	19
20	77.42	80.65	83.87	87.10	90.32	93.55	96.77	100.00	103.23	106.45	109.68	112.90	116.13	119.35	122.58	20
21	81.29	84.68	88.06	91.45	94.84	98.23	101.61	105.00	108.39	111.77	115.16	118.55	121.94	125.32	128.71	21
22	85.16	88.71	92.26	95.81	99.35	102.90	106.45	110.00	113.55	117.10	120.65	124.19	127.74	131.29	134.84	22
23	89.03	92.74	96.45	100.16	103.87	107.58	111.29	115.00	118.71	122.42	126.13	129.84	133.55	137.26	140.97	23
24	92.90	96.77	100.65	104.52	108.39	112.26	116.13	120.00	123.87	127.74	131.61	135.48	139.35	143.23	147.10	24
25	96.77	100.81	104.84	108.87	112.90	116.94	120.97	125.00	129.03	133.06	137.10	141.13	145.16	149.19	153.23	25
26	100.65	104.84	109.03	113.23	117.42	121.61	125.81	130.00	134.19	138.39	142.58	146.77	150.97	155.16	159.35	26
27	104.52	108.87	113.23	117.58	121.94	126.29	130.65	135.00	139.35	143.71	148.06	152.42	156.77	161.13	165.48	27
28	108.39	112.90	117.42	121.94	126.45	130.97	135.48	140.00	144.52	149.03	153.55	158.06	162.58	167.10	171.61	28
29	112.26	116.94	121.61	126.29	130.97	135.65	140.32	145.00	149.68	154.35	159.03	163.71	168.39	173.06	177.74	29
30	116.13	120.97	125.81	130.65	135.48	140.32	145.16	150.00	154.84	159.68	164.52	169.35	174.19	179.03	183.87	30
31	120.00	125.00	130.00	135.00	140.00	145.00	150.00	155.00	160.00	165.00	170.00	175.00	180.00	185.00	190.00	31

31 DAY MONTH 31
TABLE OF AMOUNTS EARNED AT VARIOUS MONTHLY RATES

Days	Amount Earned at Different Rates															Days
	195.00	200.00	205.00	210.00	215.00	220.00	225.00	230.00	235.00	240.00	245.00	250.00	275.00	300.00	325.00	
1	6.29	6.45	6.61	6.77	6.94	7.10	7.26	7.42	7.58	7.74	7.90	8.06	8.87	9.68	10.48	1
2	12.58	12.90	13.23	13.55	13.87	14.19	14.52	14.84	15.16	15.48	15.81	16.13	17.74	19.35	20.97	2
3	18.87	19.35	19.84	20.32	20.81	21.29	21.77	22.26	22.74	23.23	23.71	24.19	26.61	29.03	31.45	3
4	25.16	25.81	26.45	27.10	27.74	28.39	29.03	29.68	30.32	30.97	31.61	32.26	35.48	38.71	41.94	4
5	31.45	32.26	33.06	33.87	34.68	35.48	36.29	37.10	37.90	38.71	39.52	40.32	44.35	48.39	52.42	5
6	37.74	38.71	39.68	40.65	41.61	42.58	43.55	44.52	45.48	46.45	47.42	48.39	53.23	58.06	62.90	6
7	44.03	45.16	46.29	47.42	48.55	49.68	50.81	51.94	53.06	54.19	55.32	56.45	62.10	67.74	73.39	7
8	50.32	51.61	52.90	54.19	55.48	56.77	58.06	59.35	60.65	61.94	63.23	64.52	70.97	77.42	83.87	8
9	56.61	58.06	59.52	60.97	62.42	63.87	65.32	66.77	68.23	69.68	71.13	72.58	79.84	87.10	94.35	9
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31	195.00	200.00	205.00	210.00	215.00	220.00	225.00	230.00	235.00	240.00	245.00	250.00	275.00	300.00	325.00	31

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